

Appendices

Appendix K: Wastewater Flow Monitoring

Appendices

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Wastewater Flow Monitoring Services

For

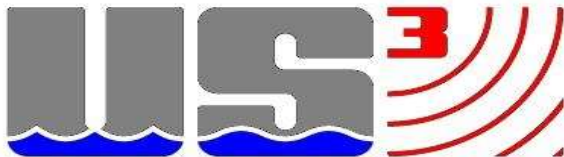


Brea Mall Mixed Use Project

1065 Brea Mall

Brea, CA 92821

September 24, 2019 through October 10, 2019

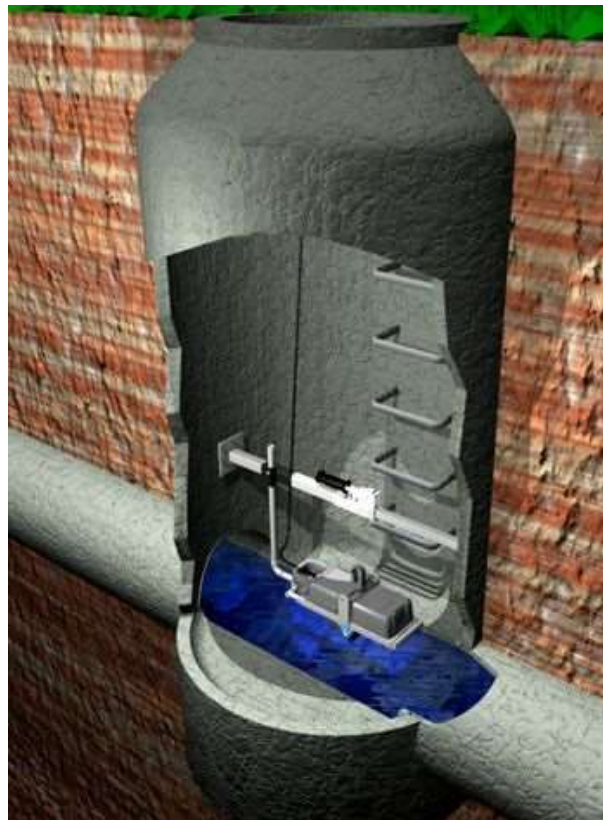


Leaders in Sewer Flow Monitoring
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CERTIFICATION PAGE

**Brea Mall Mixed Use Project
Sewer Flow Monitoring Study
September 24 - October 10, 2019**

"I certify that this document and all of its attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the data submitted. Based on my inquiry of the persons who installed the flow monitoring equipment and those persons directly responsible for gathering the data, the information submitted in this report is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that as a Registered Professional Engineer in the State of California, I am ethically bound to provide services honestly and to protect the public health, safety, and welfare."



Signed on:

11/19/2021

A handwritten signature in blue ink, appearing to read "C. D. Szczublewski", written over a horizontal line.

Constance Darlene Szczublewski, RCE 78908
Registration Expires March 31, 2022

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Tab 1: Overview & Site-Specific Information***1.1 Overview***

The City of Brea (City) currently serves a population of approximately 41,000 people within a 12 square mile area. The City's wastewater collection system is managed by the City's Street, Sewer, Storm Drain & Sanitation Division. The collection system consists of about 119 miles of gravity sewer lines and three pump (lift) stations. Flows from these local sewers discharge into Orange County Sanitation District facilities for treatment and disposal.

City personnel provide engineering evaluation of proposed and existing sewer facilities, administer the City's sewer service charge ordinance, carry out annexation proceedings for new service areas, form and dissolve service zones, maintain facility record plans and administer preventive maintenance and sewer construction programs. Since the City is responsible for properly managing, operating, and maintaining all portions of their wastewater collection system, as well as providing adequate capacity to carry peak capacity flows, sewer flow monitoring is required as a condition of development whenever a project proposes to construct 10 or more residential dwelling units or add 10,000 square feet (sf) or more of commercial space. This requirement not only helps to ensure adequate capacity, but continually updates their databases with the most current information, allowing the City to improve the condition and performance of its wastewater collection system, reducing the occurrences of SSOs, and ensuring the health and safety of the community.

1.2 Project Description

Utility Systems Science & Software, Inc. (US³) was contracted by raSmith to perform sewer flow monitoring at five sewer manholes for a period of seven days for their Brea Mall Mixed Use Project. Two sewer monitoring sites within Brea Mall were selected for concurrent monitoring with three downstream manholes. This sewer system assessment was developed under conditions existing between 09/24/2019 and 10/10/2019 to analyze for potential capacity limitations in the monitored lines, which includes the anticipated effects of redeveloping the property at 1065 Brea Mall in Brea.

The Brea Mall encompasses approximately 74 acres in northeast Orange County. The Mall is west of State Route 57 (SR-57) and is generally bounded by State College Boulevard to the east, Imperial Highway (SR 91) to the south, S. Randolph Av to the west, the City of Brea City Hall and Embassy Suites by Hilton to the northwest, and E. Birch St to the north. The project site is generally in the southwest portion of the Brea Mall, in the area formerly occupied by Sears.

US³ assessed permitting and traffic control requirements for the selected monitoring sites. Site-specific diagrams from the California Work Area Traffic Control Handbook (CA WATCH) were prepared for submittal with the City Encroachment Permit applications, which fully conformed with the California Manual of Uniform Traffic Control Devices. Due to the distance between the monitoring locations, two encroachment permits were approved by the City prior to flow monitoring.

US³ performed site inspections to evaluate the site hydraulics at the selected monitoring sites as part of the installation process. **Note:** Each wastewater collection system is different, and some of the differences that affect flow monitoring include: slope of sewer line; age, condition and material of sewer line; number and type of connections; and sewer design, specifically the proximity of baffles, drop structures, pumps, siphons, and weirs. Only one of these structures was noted during the initial installations, which was a drop inlet, but since no flow was observed discharging from the drop inlet, it was deemed acceptable for flow monitoring during the inspection. Therefore, the initial installations occurred on 09/24/2019 at the Nordstrom MH and at Sites 1, 2, 3 and 4.

Upon review of the field installation documents and photos, it was determined that what were assumed to be the locations of Sites 3 and 4 were actually Site 3A (most likely a brine line) and Site 3. Therefore, installation at the correct Site 4 MH occurred on 10/02/2019. Monitoring at the Site 4 MH is referred to as the second week of monitoring or secondary monitoring. The monitoring site locations and sewer lines for both the first and second week of monitoring are shown on maps in Section 1.3.

The manholes were equipped with Hach Marsh-McBirney Flo-Dar® AV Sensors and Loggers. With the installation and removal of the equipment, the manholes were opened and confined space entry was limited to crossing the plane with hands and arms, but not actually entering the manholes. Even though US³ personnel did not enter the manholes during equipment installation or removal, they were fully trained and certified in Confined Space Entry and CPR, and in accordance with safety standards, gas readings were taken and recorded throughout the duration of the installation and removal process.



In summary, US³ performed the following services as part of this project:

- Sewer Flow Monitoring
 - Assessment of permitting and traffic control requirements
 - Installation of Marsh-McBirney Flo-Dar® AV Sensor/s and Logger/s
 - Validation of hydraulic suitability
 - Calibration of flow monitoring equipment
 - Documentation of installation and calibration
 - First week of flow monitoring between 09/24/2019 and 10/02/2019
 - Second week of flow monitoring between 10/02/2019 and 10/10/2019
 - Removal of flow monitoring equipment
 - Validation of flow monitoring data
- Evaluation of the sanitary sewer at the monitored sites
- Development of a report to discuss the flow monitoring data, including system statistics and graphs

1.3 Existing and Proposed Site Maps

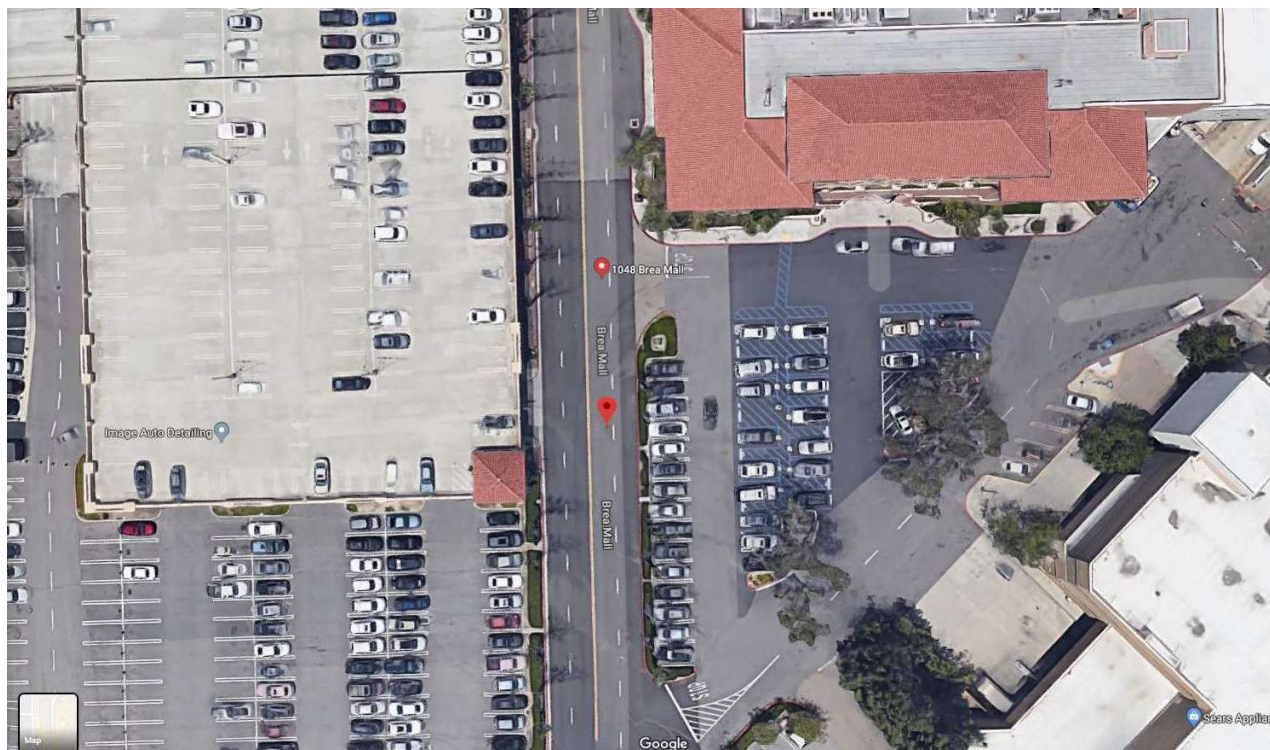
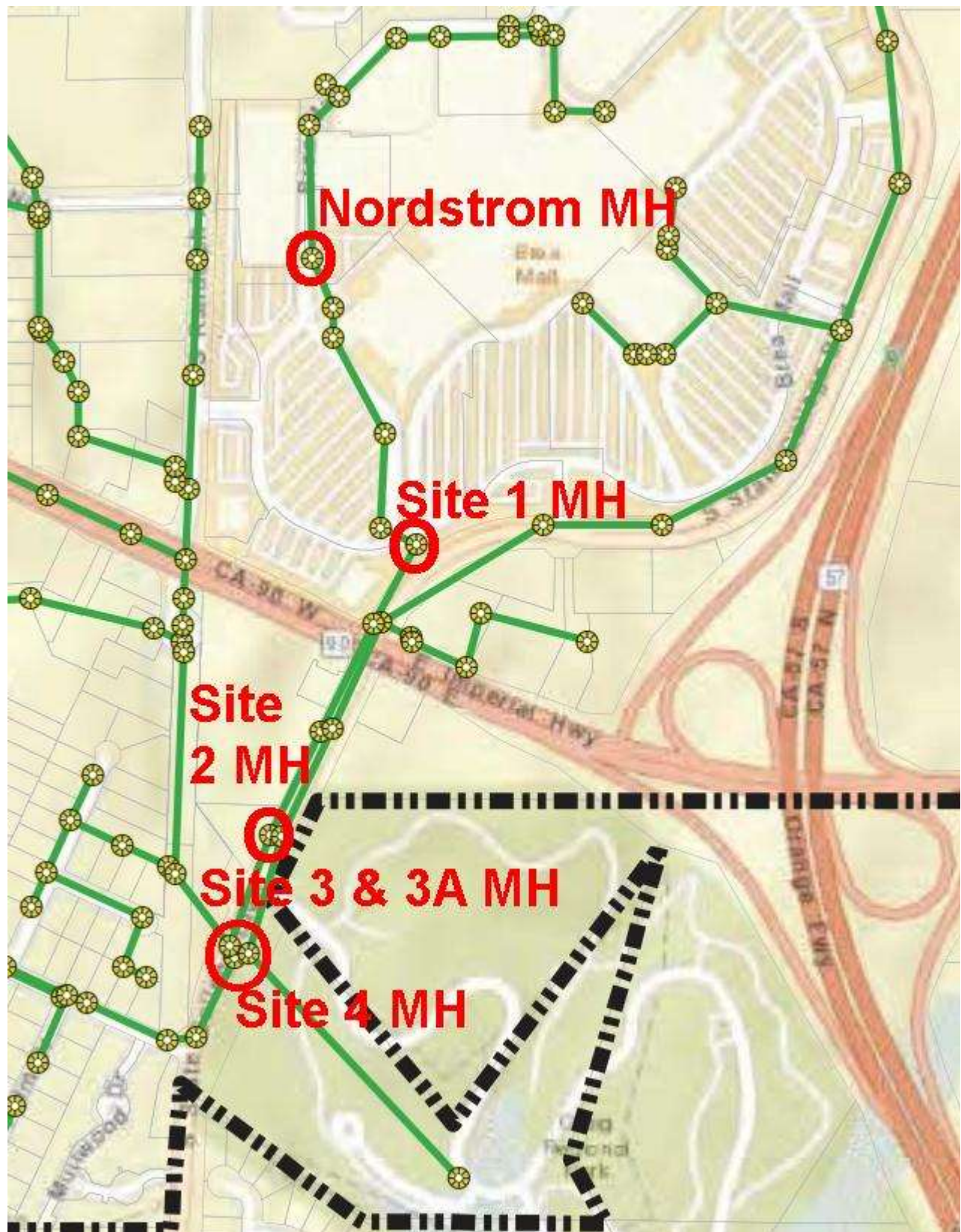
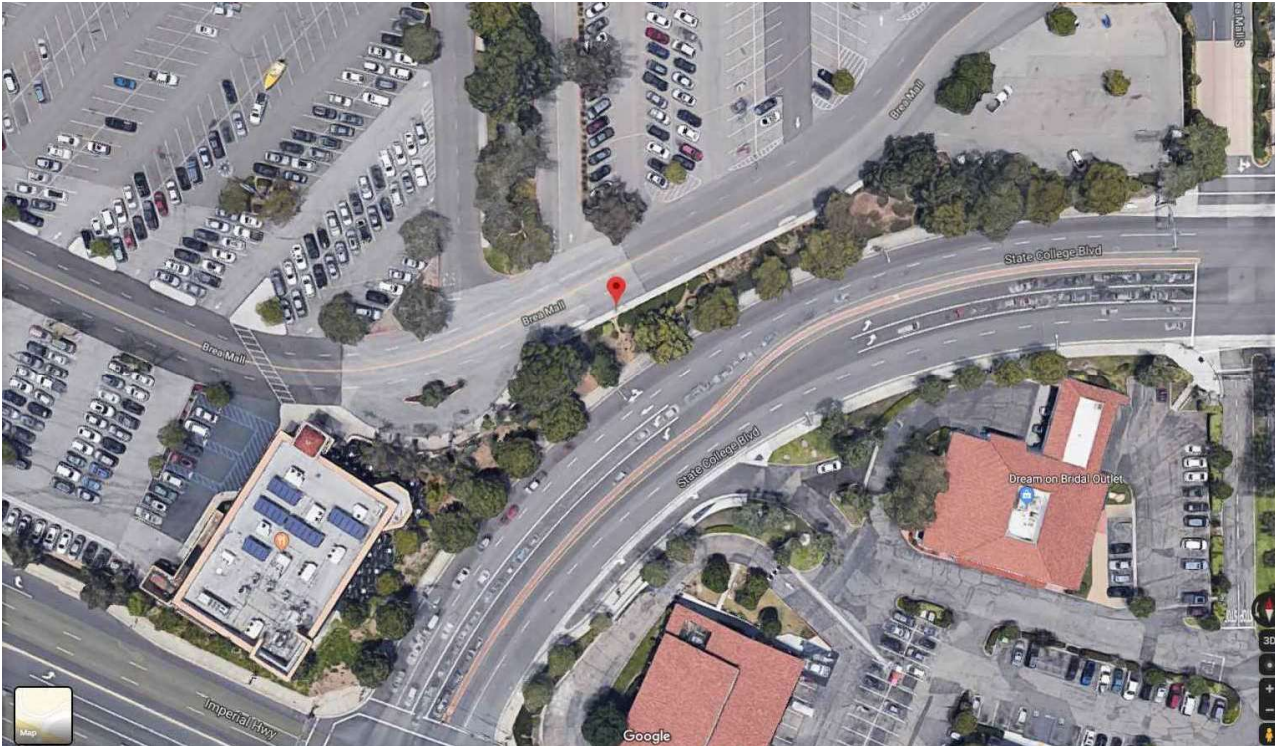


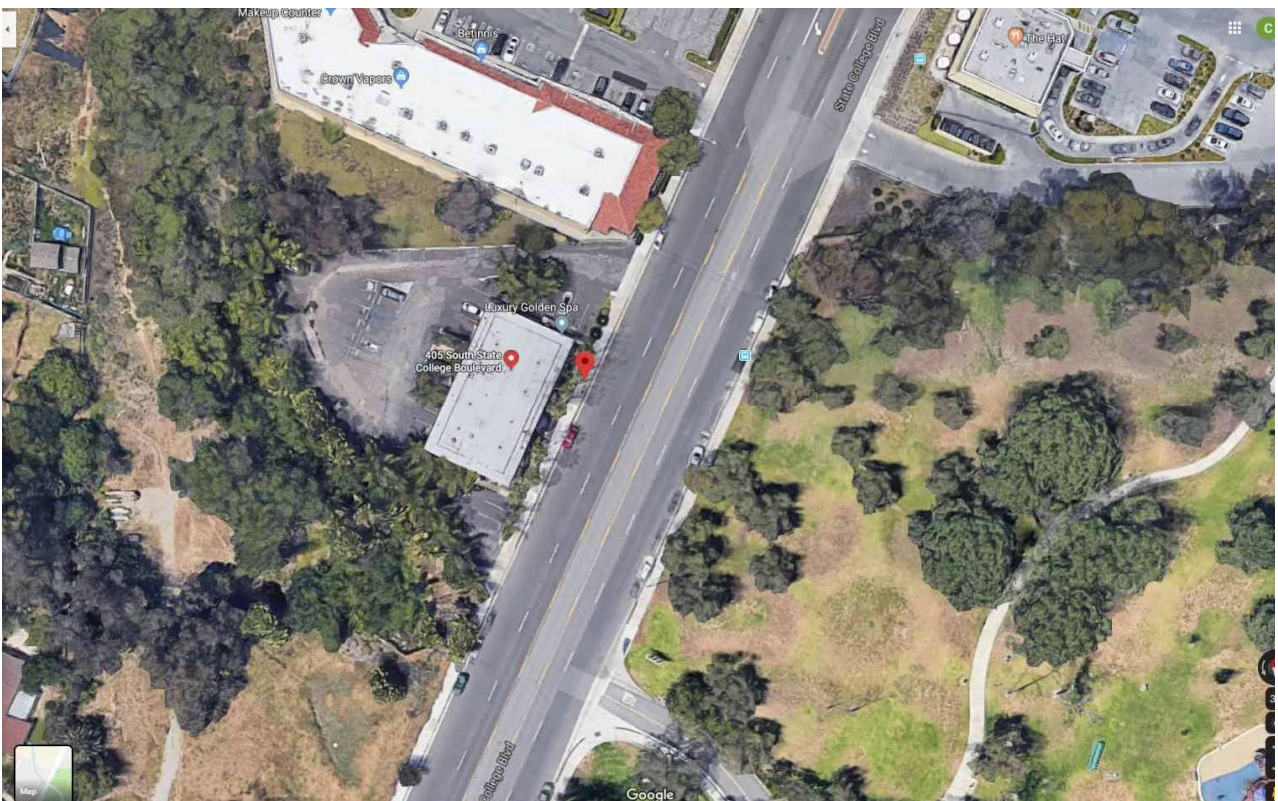
Figure above: The vicinity map shows the temporary wastewater flow monitoring location of the Nordstrom MH. The Nordstrom MH is located at latitude 33.915117 and longitude -117.888619.

Figure below: The sewer map shows the plan view of all seven of the monitored sewer lines.





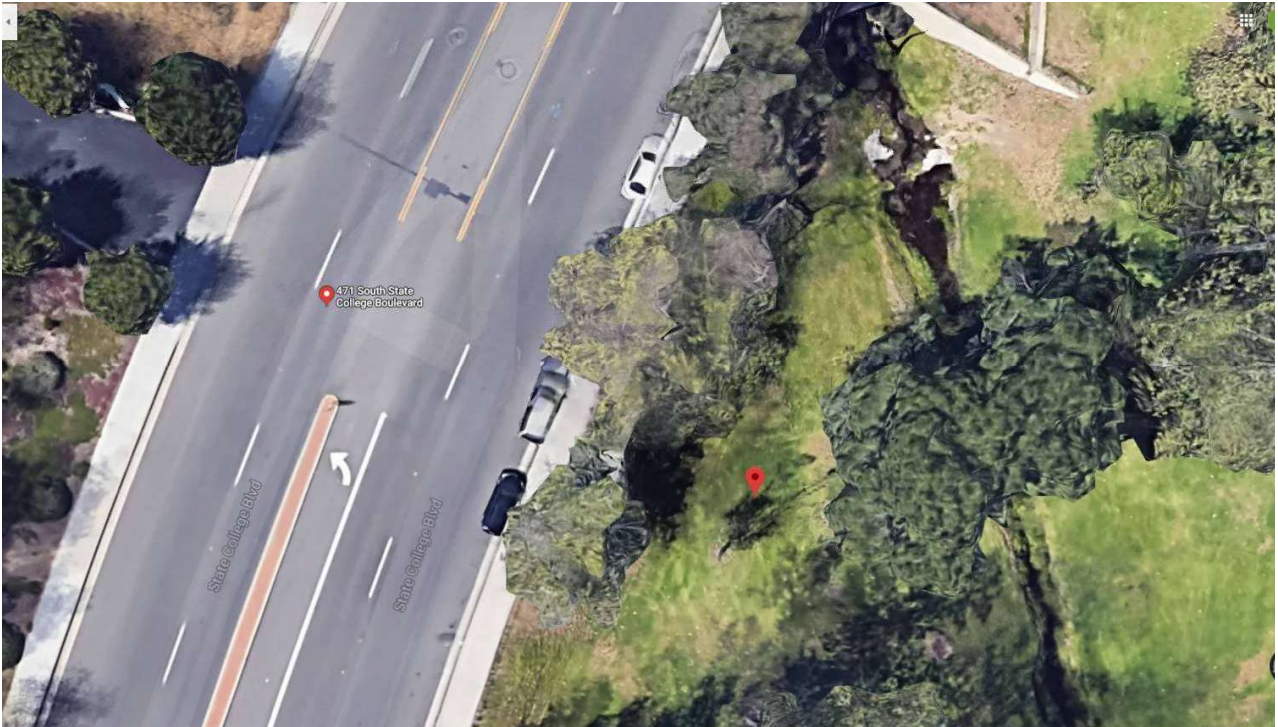
Figures: The vicinity map (above) shows the temporary wastewater flow monitoring location of the Site 1 MH. The Site 1 MH is located at latitude 33.912802 and longitude -117.887424. The vicinity map (below) shows the temporary wastewater flow monitoring location of the Site 2 MH. The Site 2 MH is located at latitude 33.910330 and longitude -117.888919.



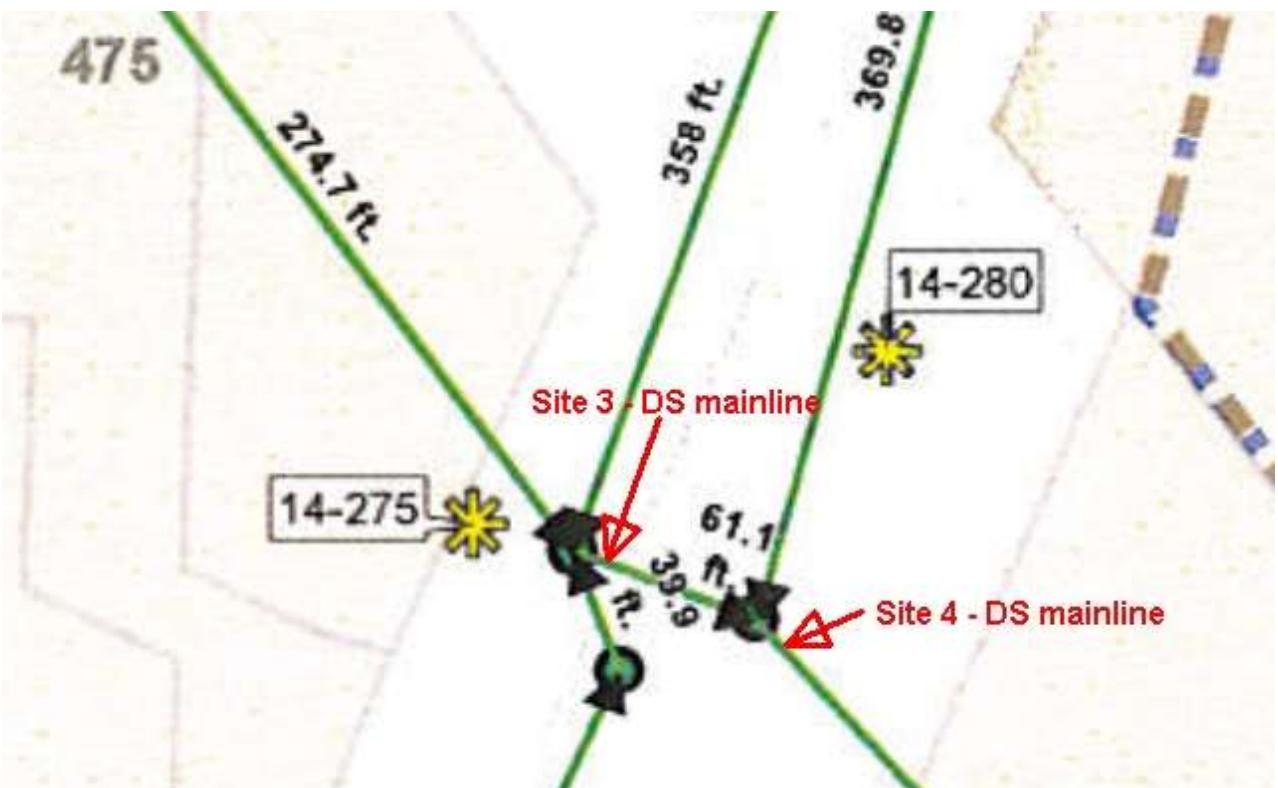


Figures: The vicinity map (above) shows the temporary wastewater flow monitoring locations of the Site 3A MH and the Site 3 MH. Site 3A MH is at latitude 33.909343 and longitude -117.889338 and Site 3 MH is at latitude 33.909322 and longitude -117.889302. The sewer map (below) shows the locations of Sites 3 and 4, which were incorrectly identified during the first week of monitoring.





Figures: The vicinity map (above) shows the temporary wastewater flow monitoring location of the Site 4 MH. The Site 4 MH is located at latitude 33.909049 and longitude -117.889105. The sewer map (below) shows the locations of Sites 3 and 4, which were incorrectly identified during the first week of monitoring; the Site 4 MH being must farther east than show



[illegible]

The project proposes to change the current land use from strictly commercial to a mixed use of commercial and residential. The existing onsite sewer line shown in red and gray will be removed and the new proposed sewer lines shown in bold red will be constructed. The proposed redevelopment consists of a fitness center, sporting goods store, small shops, restaurant and residential dwelling units as shown in Table 1 on page 32 of this report. The proposed 10-inch (in) sewer line will be carrying only the existing and proposed commercial flow. The proposed 10-in sewer line will tie into the existing offsite 8-in sewer line at a new manhole downstream from the Site 1 MH in order to enter the existing sewer line at a better angle, and thereby improving the hydraulics in the line and in the Site 1 MH.

1.4 Monitoring Site Installations



Figure at left: The photo shows the Nordstrom MH in the left-hand northbound lane at ~1048 Brea Mall. Surface conditions were dry. No issues were encountered during the installation on 9/24/2019 or the removal on 10/02/2019.

Figure at right: This was a commercial access road with a low-speed limit, so the field team used cones, signs and an arrow board in accordance with CA WATCH Diagram 15 during installation and removal of the monitoring equipment.

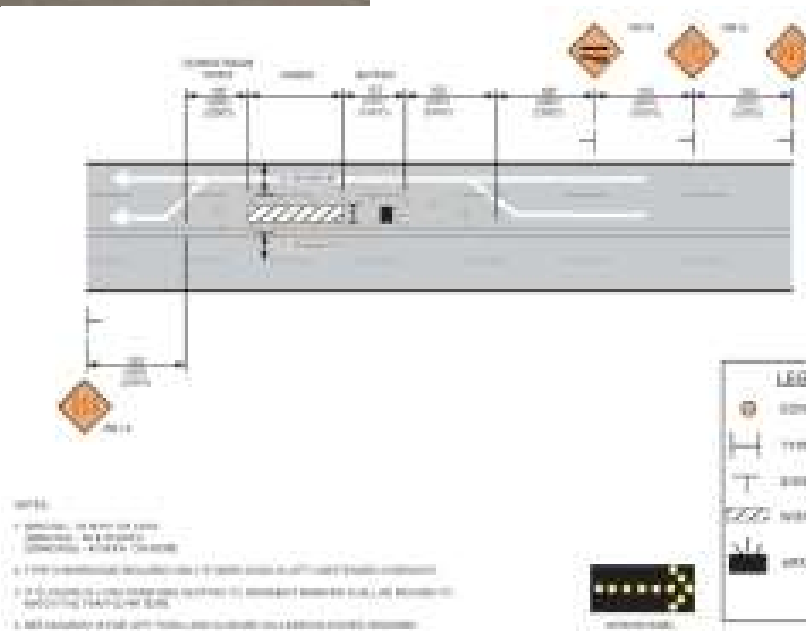




Figure above: The Nordstrom MH provided access to an 8-in sewer line, which entered from the north and discharged to the southeast. Gas levels were good (well within OSHA acceptable limits: $O_2=20.9\%$; LEL, H_2S & $CO=0$). The flow monitoring equipment was set to monitor the downstream pipe as it provided the best hydraulics. Follow up on this installation confirmed equipment calibration.

Figures below: The left photo shows the Site 1 MH on the sidewalk at ~120 Brea Mall. This was adjacent to commercial access road with a low-speed limit, so the field team used cones, signs and an arrow board in accordance with CA WATCH Diagram 2 during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered during installation on 9/24/2019 or removal on 10/02/2019.

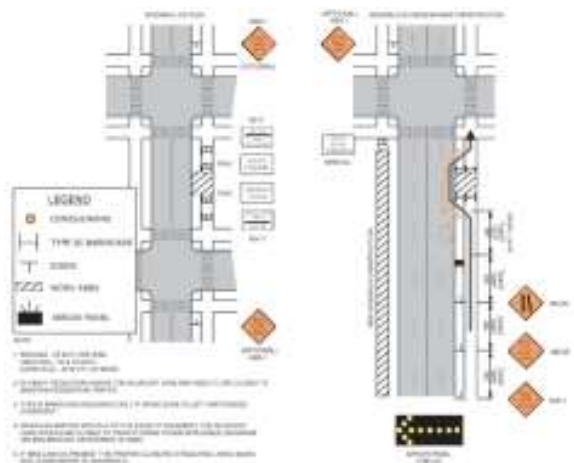


Figure above: The Site 1 MH provided access to an 8-in sewer line, which entered from the northeast and discharged to the southwest. Two laterals entered from the northwest and southeast, but according to the sewer maps, there should only be one upstream line entering from the northwest. Gas levels were good. The flow monitoring equipment was set to monitor the downstream line to get the total flow. Follow up on this installation confirmed equipment calibration.

Figures below: The left photo shows the Site 2 MH on the sidewalk at ~405 S. State College Blvd. This was a commercial area, so the field team used cones and signs in accordance with CA WATCH Diagram 2 during installation and removal of the monitoring equipment, but no arrow board was needed because the parking lane was used. Surface conditions were dry. No issues were encountered during installation on 9/24/2019 or removal on 10/02/2019.

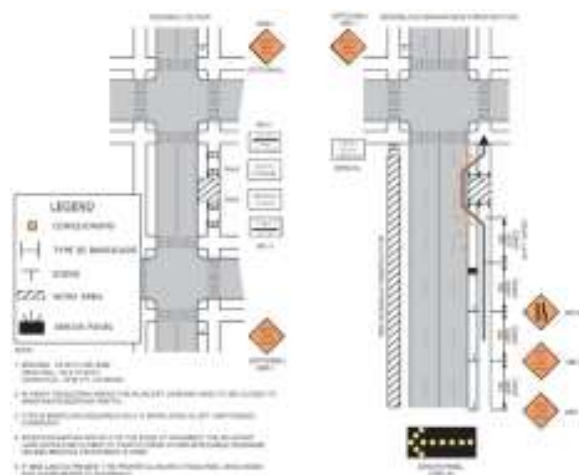


Figure at left: The Site 2 MH provided access to an 8-in sewer line, which entered from the northeast and discharged to the southwest. Gas levels were good. The flow monitoring equipment was set to monitor in the downstream direction in a position within the trough that provided the best hydraulics. Follow up on this installation confirmed equipment calibration.

Figures below: The left photo shows the Site 3A MH in the left-hand southbound lane at ~454 S. State College Blvd. This was a commercial area, so the field team used cones, signs and an arrow board in accordance with CA WATCH Diagram 15 during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered during installation on 9/24/2019 or removal on 10/02/2019.

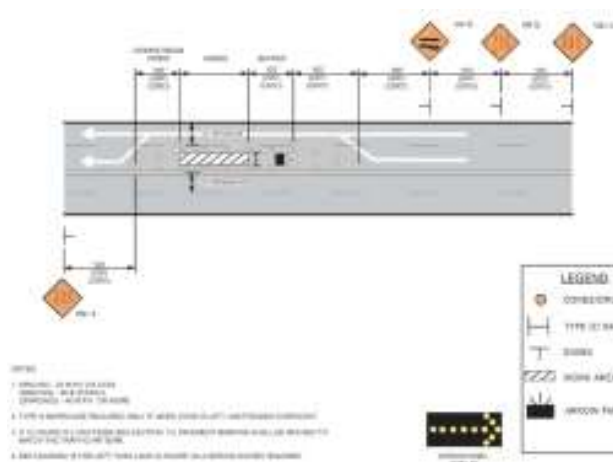


Figure above: This site was originally believed to be the Site 3 MH, but was most likely a brine line since the manhole provided access to a 6-in line, which entered from the southeast and discharged to the northwest. Follow up on this installation determined that the equipment was in the wrong manhole. The next available field crew was dispatched on 10/02/2019 to find the correct manhole in the park.

Figures below: The left photo shows the Site 3 MH in the center of the painted median at ~454 S. State College Blvd. This was a commercial area, so the field team used cones and signs in accordance with CA WATCH Diagram 20 during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered during installation on 9/24/2019 or removal on 10/02/2019.

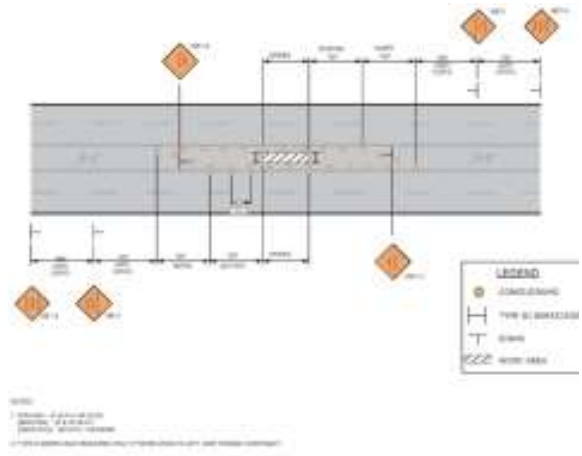


Figure above: This site was originally believed to be the Site 4 MH, but was actually the Site 3 MH. The manhole provided access to an 18-in line, which entered from the northwest and discharged to the southeast. Two laterals entered from the north; one was a drop inlet, but no flow was observed. Follow up on this installation confirmed equipment calibration.

Figures below: The photo shows the Site 4 MH in the park, east of ~471 S. State College Blvd. This was open green space, so the field team used cones to delineate their work zone during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered during installation on 10/02/2019 or removal on 10/10/2019.



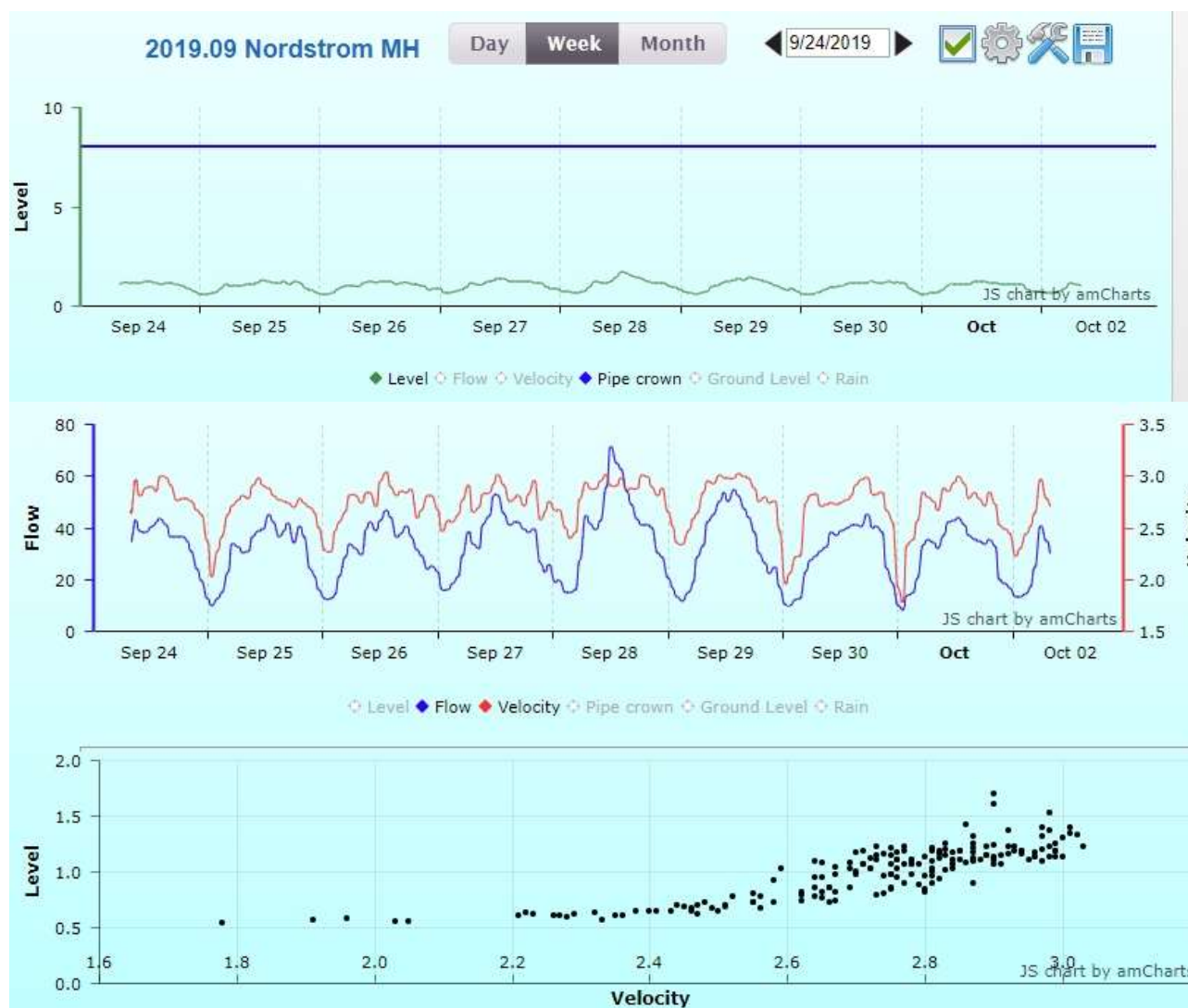
Figure above: The manhole provided access to an 18-in sewer line, which entered from the northwest and discharged to the southeast. One lateral entered from the north. Gas levels were good. The flow monitoring equipment was set to monitor the downstream line to get the total flow. Follow up on this installation confirmed equipment calibration.

1.5 Existing Capacity Analysis

The capacity evaluation method conformed to the following process:

1. Collect 15-minute interval depth and velocity data points at each site over the entire monitoring period and determine the depth versus (vs) velocity relationship or pipe curve based on Manning's equation.
2. Determine statistically the minimum, maximum and average depths and flow rates at each site during the monitoring period.
3. Calculate the maximum theoretical unobstructed flow rate at each site.
4. Determine remaining capacity under peak flow conditions at each site, using the ratios of monitored daily flow depths to pipe diameter.

Figures below: Nordstrom MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot on the previous page shows the depth vs velocity data points for the monitored pipe. The pattern of velocity and depth data points for a sewer operating in free-flow conditions over an extended period of time should conform to the depth-velocity relationship of Manning's Equation, which is the basis for evaluating flow monitoring data. This equation (shown below) defines a commonly used theoretical relationship between depth and velocity in pipes operating under free flow conditions:

$$v = 1.486/n \times R^{2/3} \times S^{1/2}$$

Where,

v = velocity (fps)

n = pipe roughness, defined as the Manning's Roughness Coefficient

R = hydraulic radius,
defined as wetted area (ft²) divided by wetted perimeter (ft)

S = hydraulic slope

The scatter plot from the Nordstrom MH shows the depth vs velocity data points for the 8-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. According to the raSmith utility plan (UP-02A), the slope of the line downstream from the Nordstrom MH should be 1.70%.

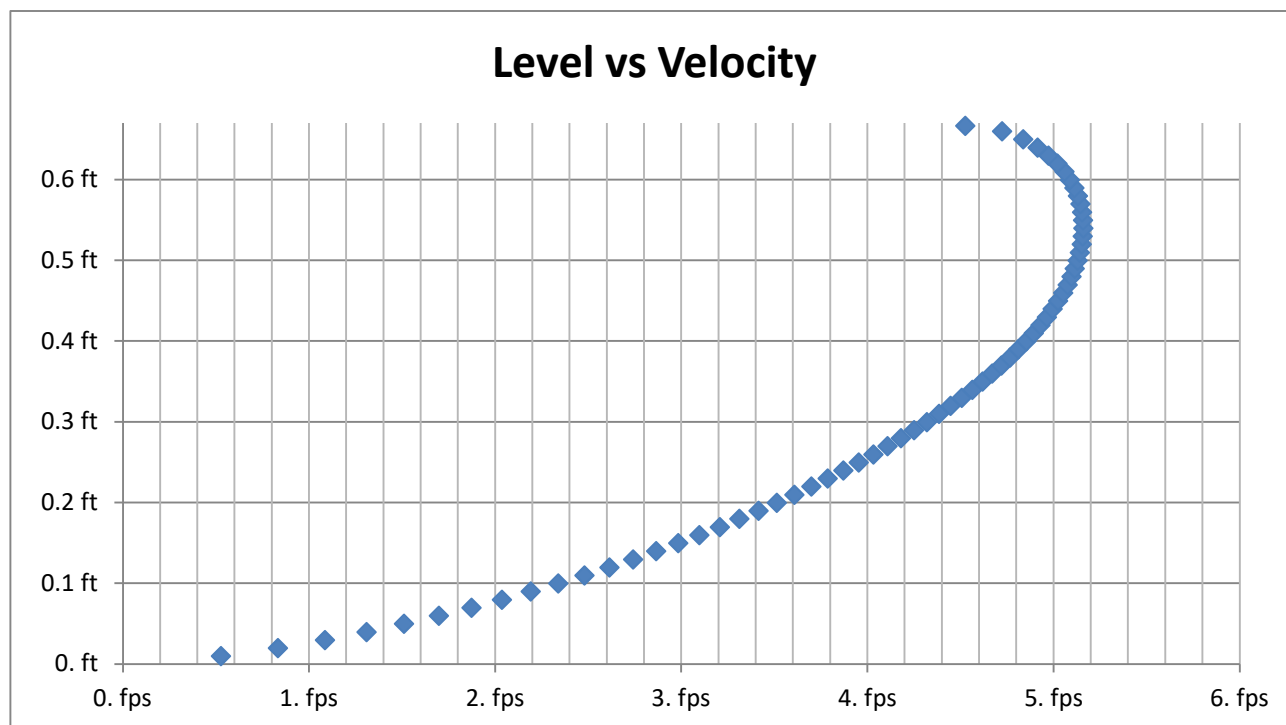


Figure above: This theoretical pipe curve was generated for an 8-in (0.67-ft) pipe with a slope of 1.70%.

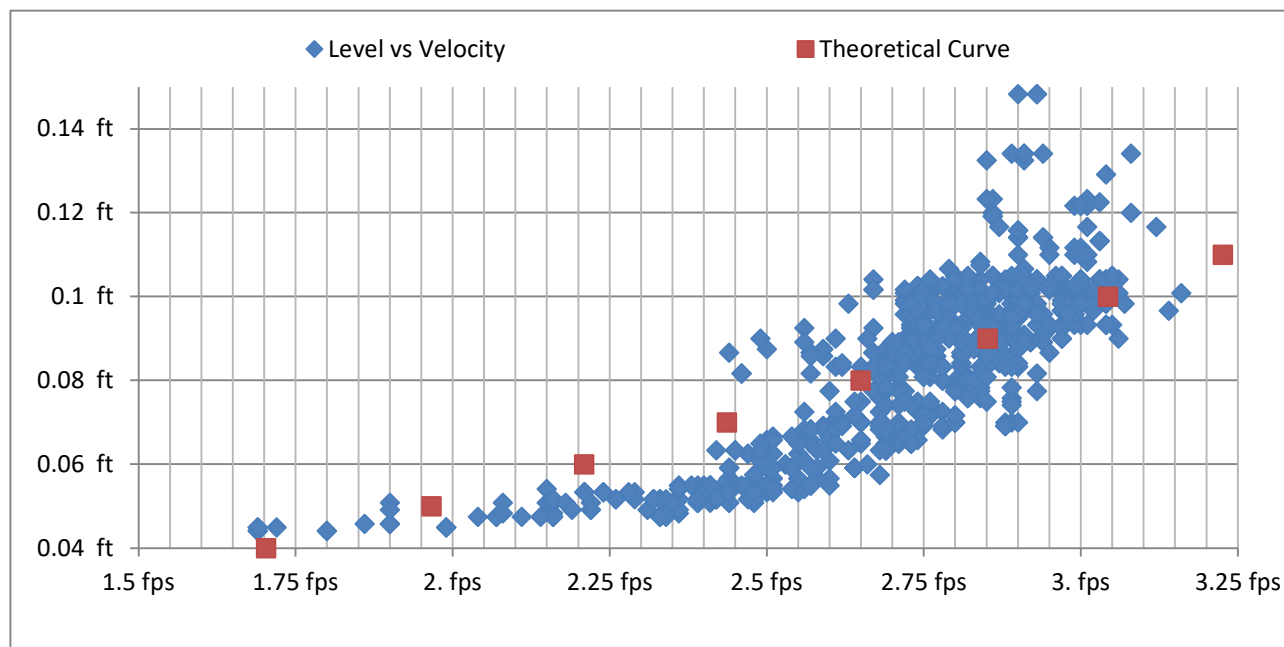


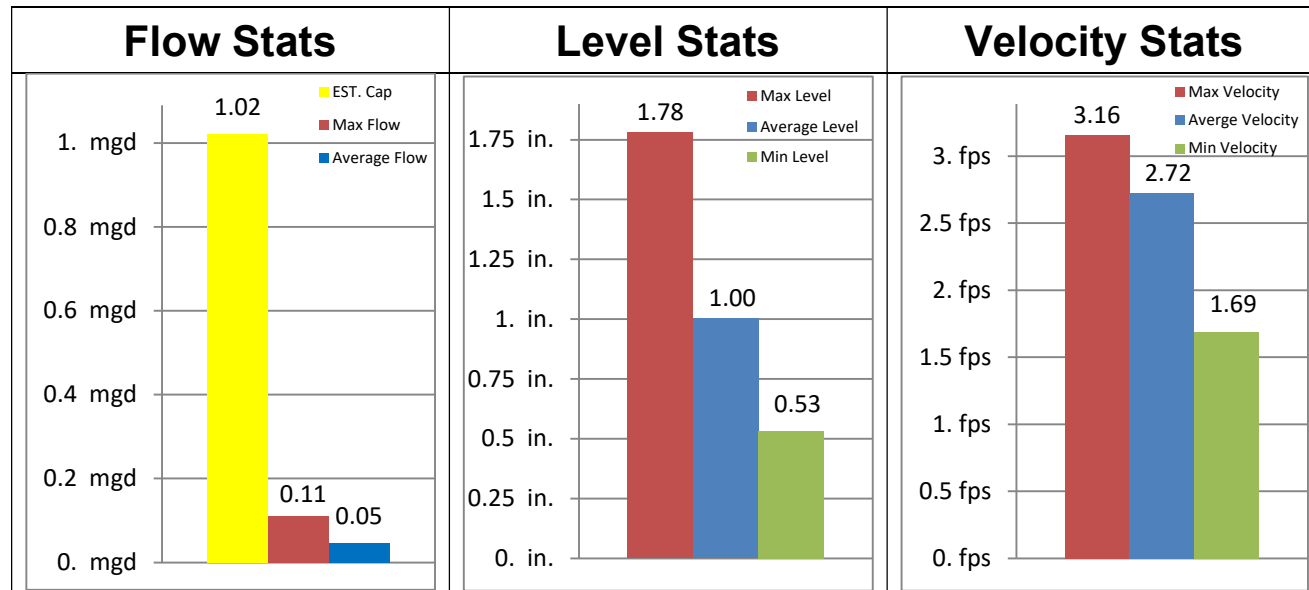
Figure above: Since the flows at the Nordstrom MH utilized ~7% to ~22% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, while a majority of the data falls into an acceptable area along the theoretical curve, there is a curvature to the data that is inconsistent with the theoretical curve. However, the curvature suggests that the data is trending toward higher velocities than expected as the levels increase.

To summarize the site statistics from the data analysis at the Nordstrom MH:

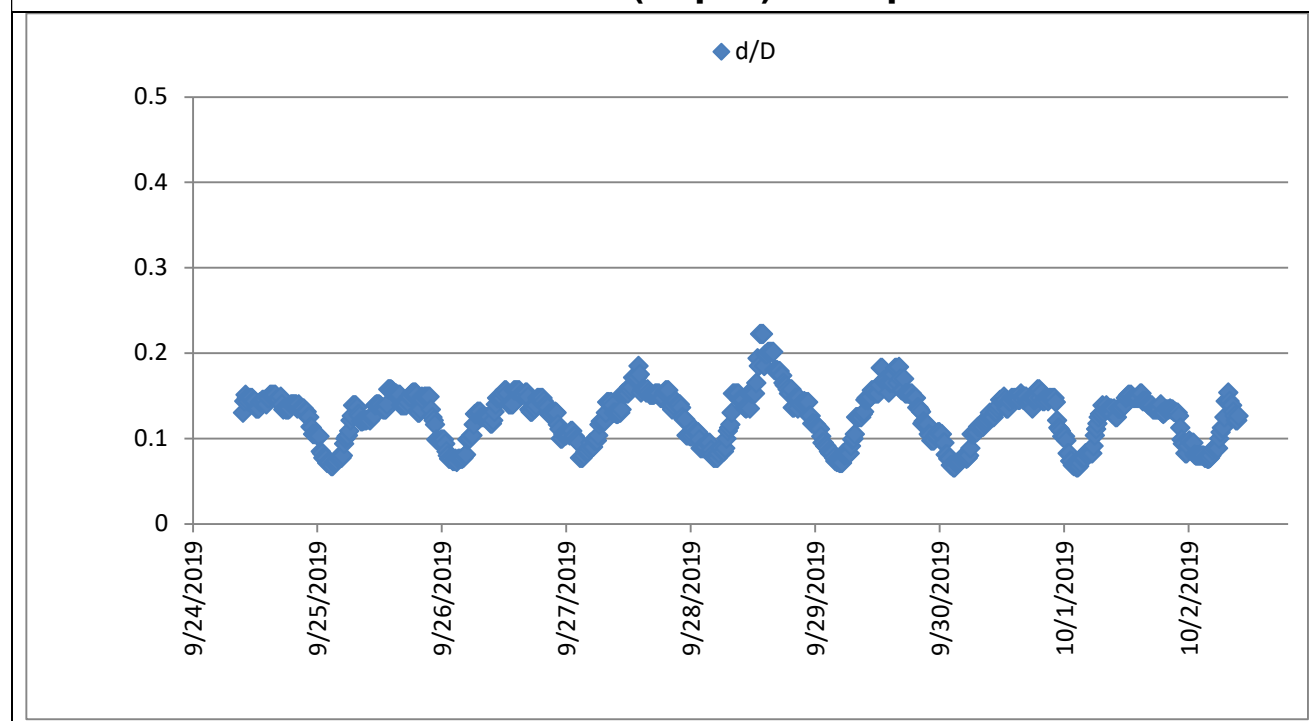
- During peak flows, 0.1090 million gallons per day (mgd) or ~76 gallons per minute (gpm) utilized ~10.7% of the pipe's capacity.
- During average flows, 0.0464 mgd or ~32 gpm utilized ~4.5% of the pipe's capacity.
- According to common practice in sewer system design, velocities need to exceed 2.0 fps a minimum (min) of once per day to provide sufficient scouring action for self-cleaning. The maximum velocity at the Nordstrom MH was 3.16 fps with an average velocity of 2.72 fps. Therefore, this site should have no issues with regard to settlement of normal system solids.
- According to the Brea Sewer System Management Plan, the depth versus diameter (d/D) ratio for existing collection system pipes of 15 inches in diameter or less should be no more than 0.50 during dry weather peak flow conditions. The average d/D ratio from the Nordstrom MH during this study was ~0.13 and the maximum (max) was ~0.22. Therefore, this 8-in pipe had capacity available during the observed dry weather peak flow.

The following is a graphical representation of site statistics (stats) from the data analysis:

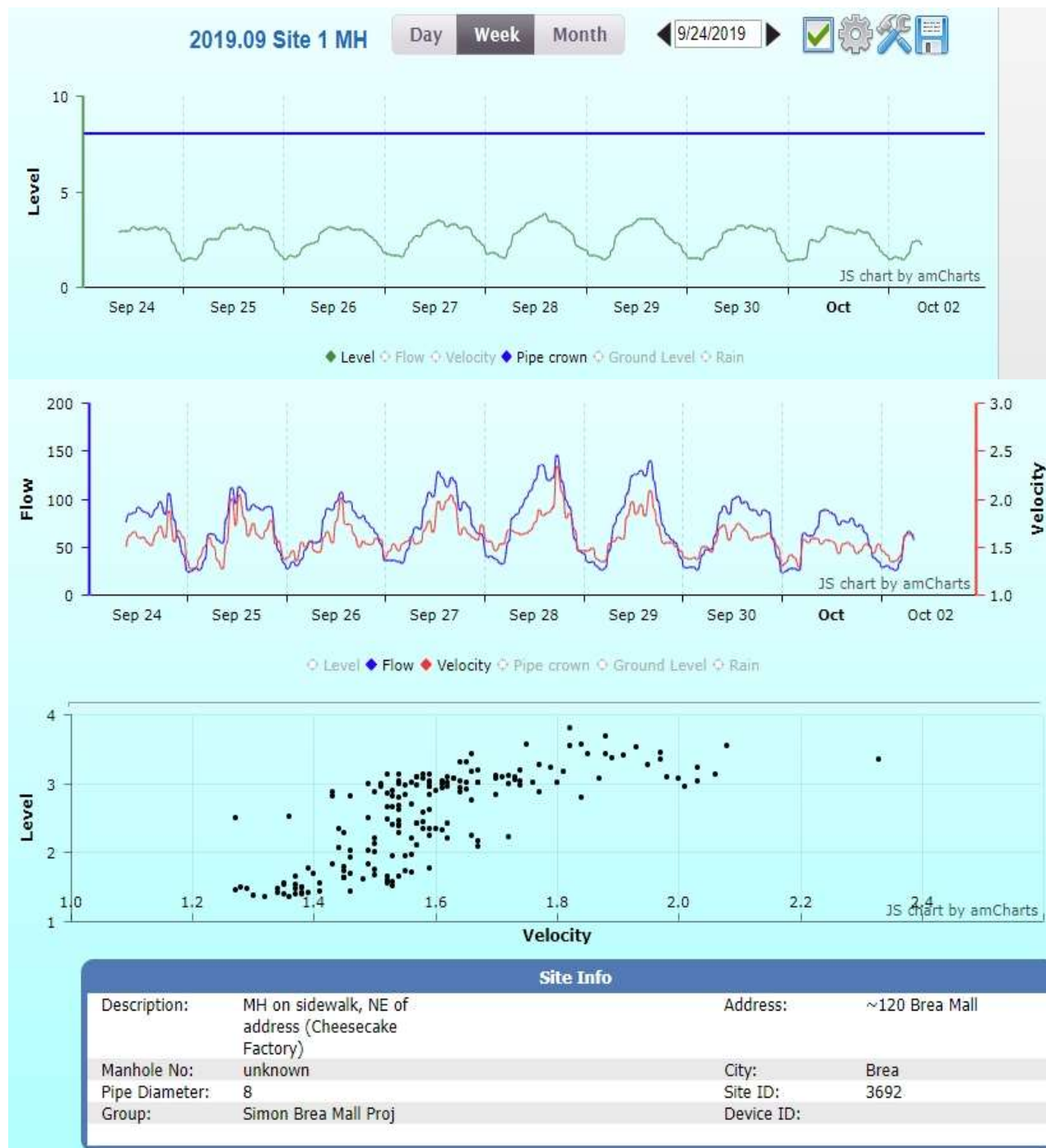


The pipe capacity was estimated using a Manning's Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with the minimum value for a vitrified clay sewer pipe (VCP) with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for an 8-in pipe with a slope of 1.70%, with the pipe completely full, the velocity is expected to be ~4.5260 fps. When this velocity is input into the Flo-Ware program from the Nordstrom MH, a maximum capacity of ~1.0211 mgd is produced.

Nordstrom MH Level (depth) vs Pipe Diameter



Figures below: Site 1 MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot above shows the depth vs velocity data points for the 8-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. According to the raSmith utility plan (UP-02A), the slope of the line downstream from the Site 1 MH should be 1.30%.

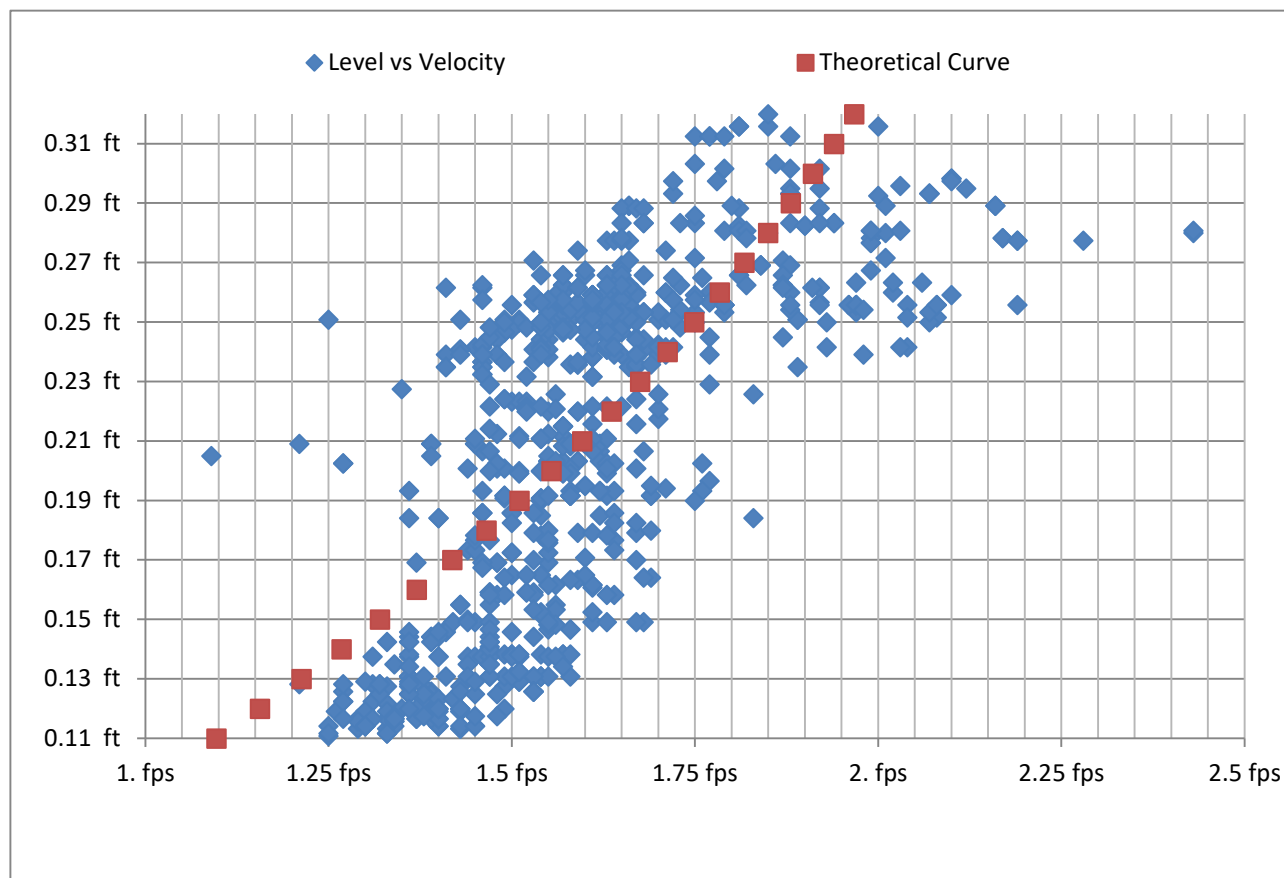


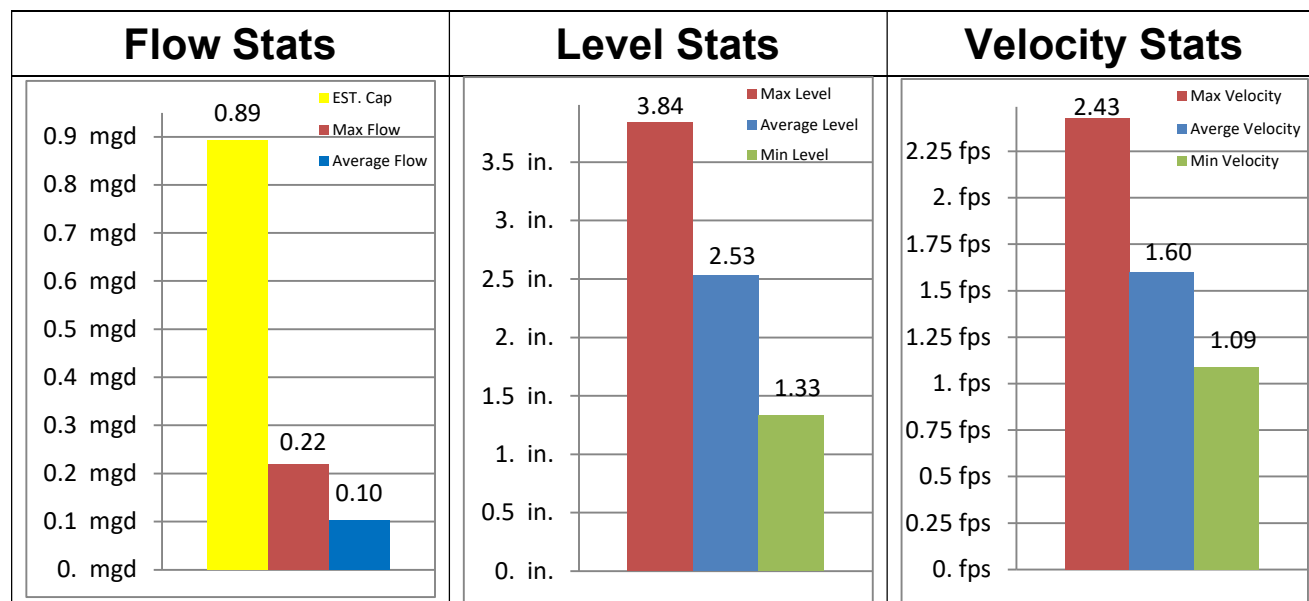
Figure above: Since the flows at the Site 1 MH utilized ~17% to ~48% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, a majority of the data falls into an acceptable area along the theoretical curve, but the distribution of the data is probably due to the hydraulics within the manhole. From the photos, it appears that inflow from the northwest line is causing turbulence, perhaps even a backwater effect in the two other upstream lines.

To summarize the site statistics from the data analysis at the Site 1 MH:

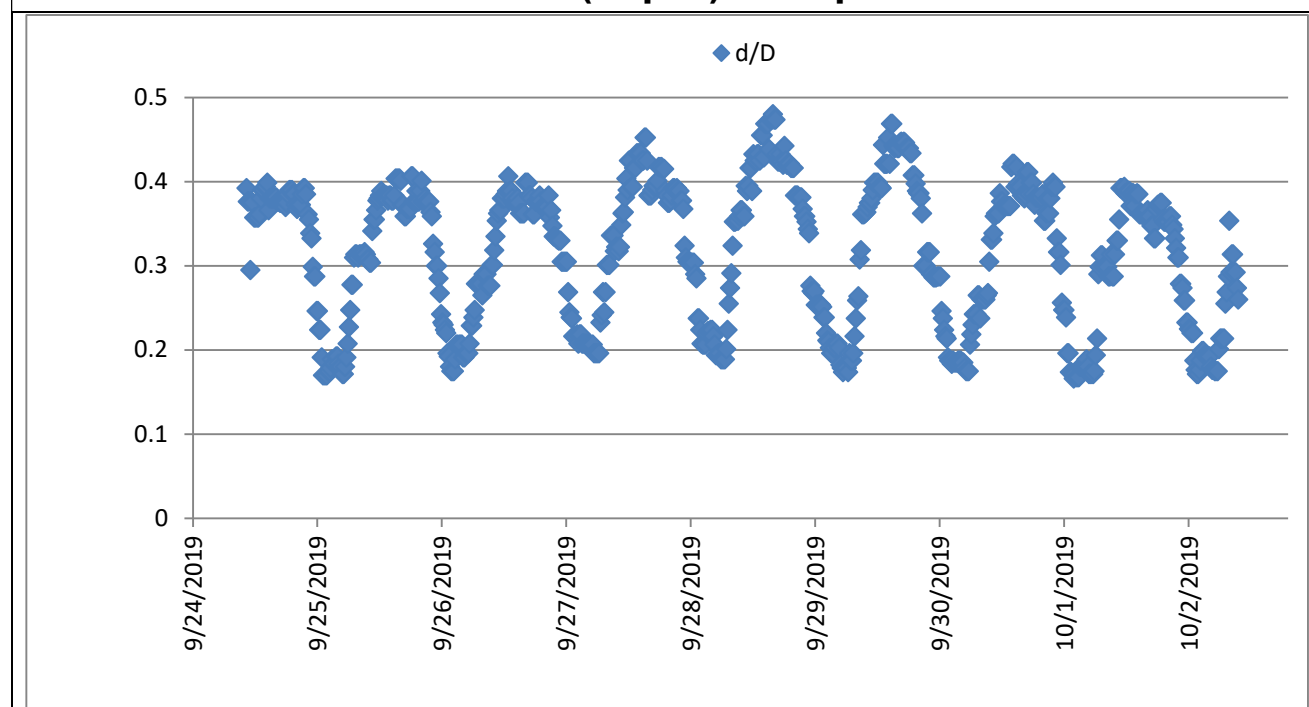
- During peak flows, 0.2194 mgd or ~152 gpm utilized ~24.6% of the pipe's capacity.
- During average flows, 0.1021 mgd or ~71 gpm utilized ~11.4% of the pipe's capacity.
- The maximum velocity at the Site 1 MH was 2.43 fps with an average velocity of 1.60 fps. Since velocities only exceeded 2 fps on five days during this 9-day study, over time, this site is likely to have issues due to settlement of normal system solids.
- The average d/D ratio from the Site 1 MH during this study was ~0.32 and the maximum was ~0.48. Therefore, this 8-in pipe had some capacity available during the observed dry weather peak flow.

The following is a graphical representation of the site statistics from the data analysis:

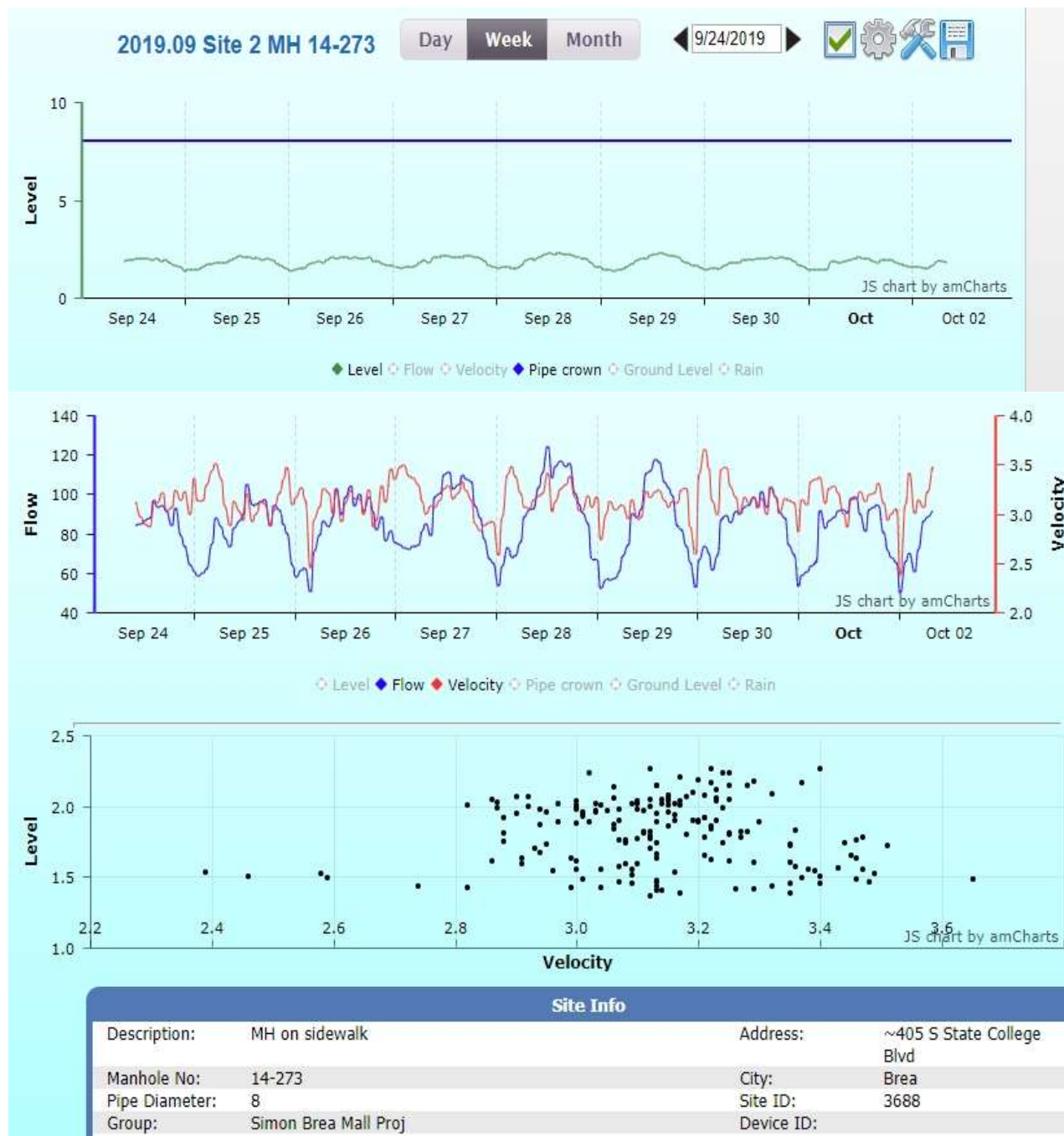


The pipe capacity was estimated using a Manning's Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with the minimum value for a VCP with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for an 8-in pipe with a slope of 1.30%, with the pipe completely full, the velocity should be ~3.9579 fps, which when input into the Flo-Ware program from the Site 1 MH produced a maximum capacity of ~0.8929 mgd.

Site 1 MH Level (depth) vs Pipe Diameter



Figures below: Site 2 MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot above shows the depth vs velocity data points for the 8-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. According to the raSmith utility plan (UP-02B), the slope of the line upstream from the Site 2 MH (RB6602-RB6601) should be 3.0%, while the slope of the line downstream from the Site 2 MH (RB6601-RB66) should be 2.16%.

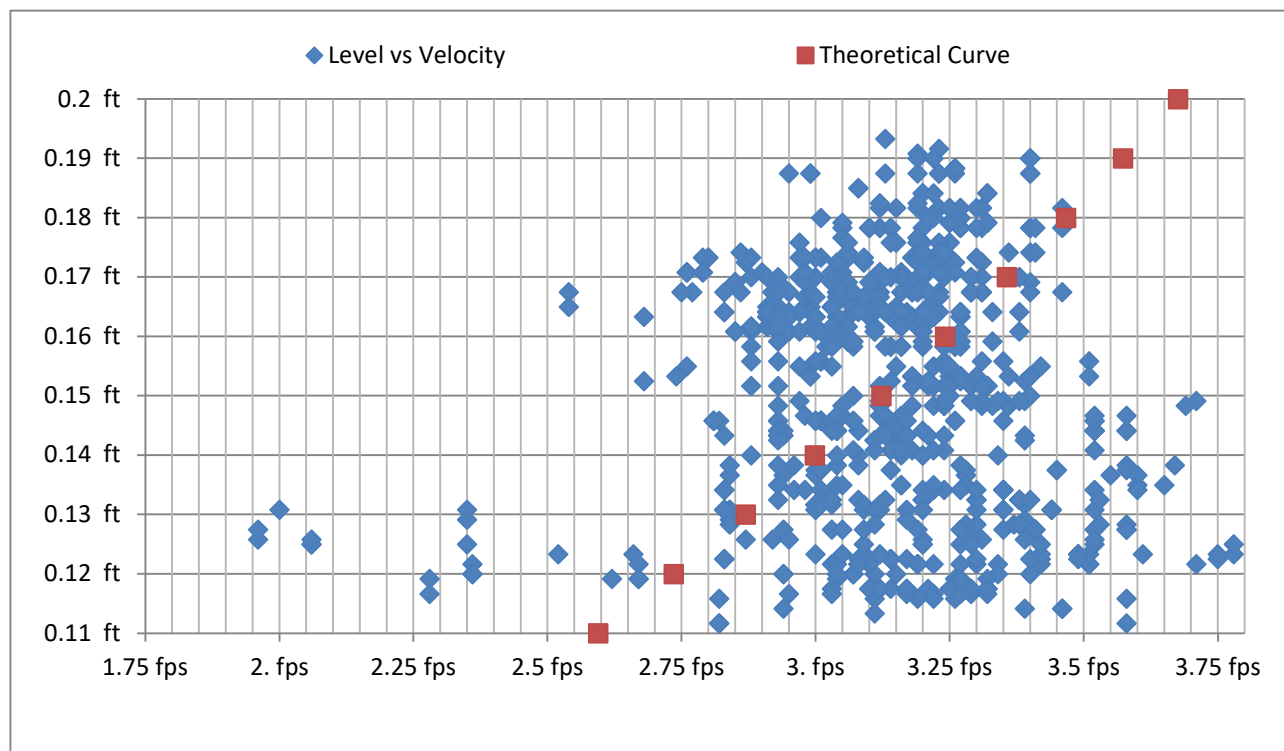


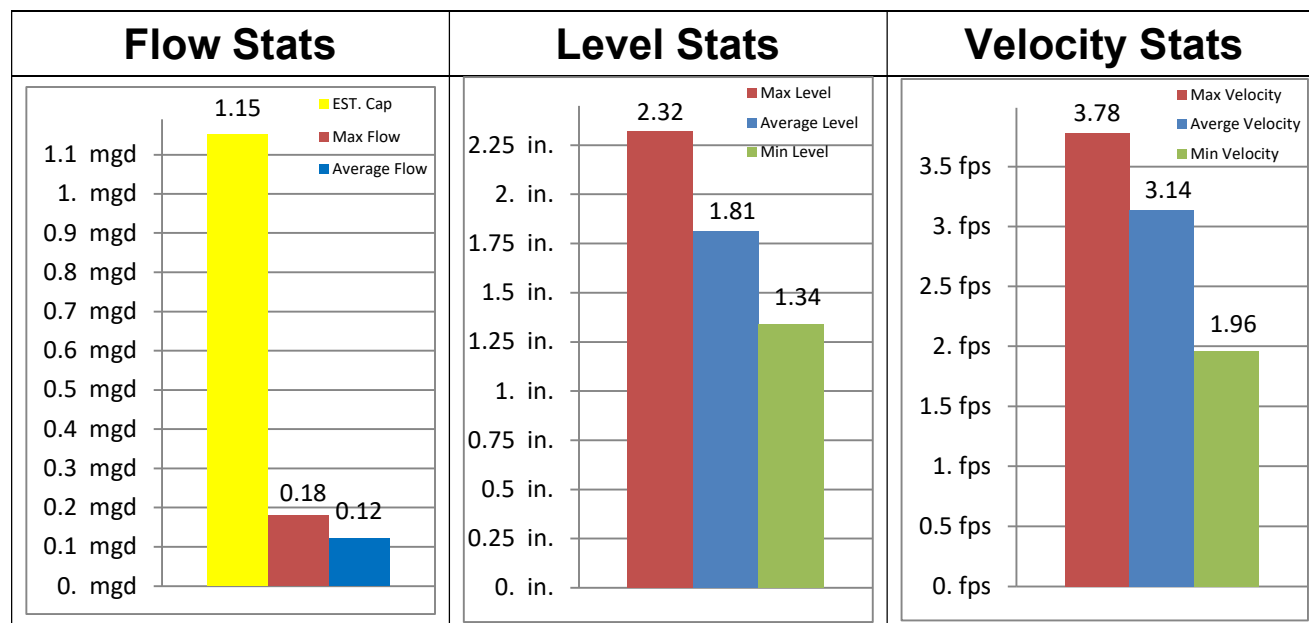
Figure above: Since the flows at the Site 2 MH utilized ~17% to ~29% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, the expected relationship between level and velocity is not prevalent. While some of the data points fall into an acceptable area along the theoretical curve, this data set is more of a cloud formation, which is indicative of processed or non-conforming flow. This is flow that does not conform to the theoretical level-velocity relationship expected under free-flow conditions, such as what occurs during dumping, jetting, pumping, etc. This type of flow is more common in commercial and industrial areas because they are more likely to generate processed flows.

To summarize the site statistics from the data analysis at the Site 2 MH:

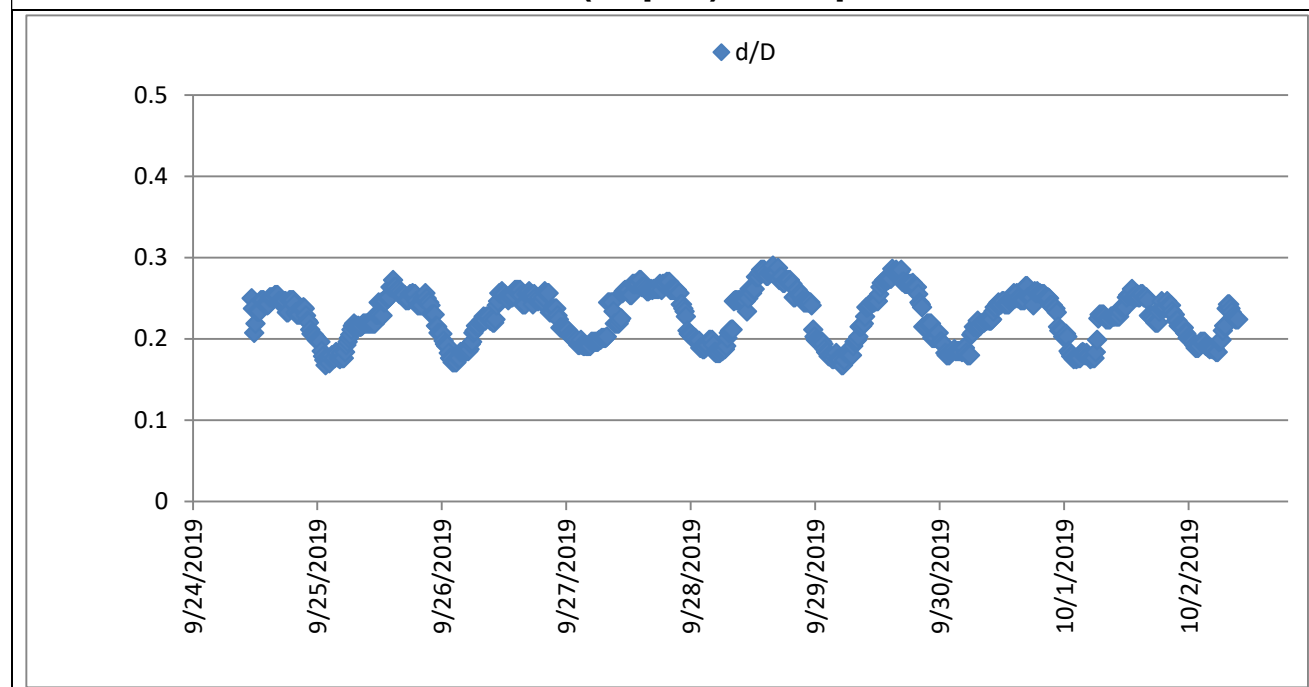
- During peak flows, 0.1798 mgd or ~125 gpm utilized ~15.6% of the pipe's capacity.
- During average flows, 0.1211 mgd or ~84 gpm utilized ~10.5% of the pipe's capacity.
- The maximum velocity at the Site 2 MH was 3.78 fps with an average velocity of 3.14 fps. Therefore, this site should have no issues with regard to blockage due to settlement of normal system solids.
- The average d/D ratio from the Site 2 MH during this study was ~0.23 and the maximum was ~0.29. Therefore, this 8-in pipe had capacity available during the observed dry weather peak flow.

The following is a graphical representation of the site statistics from the data analysis:

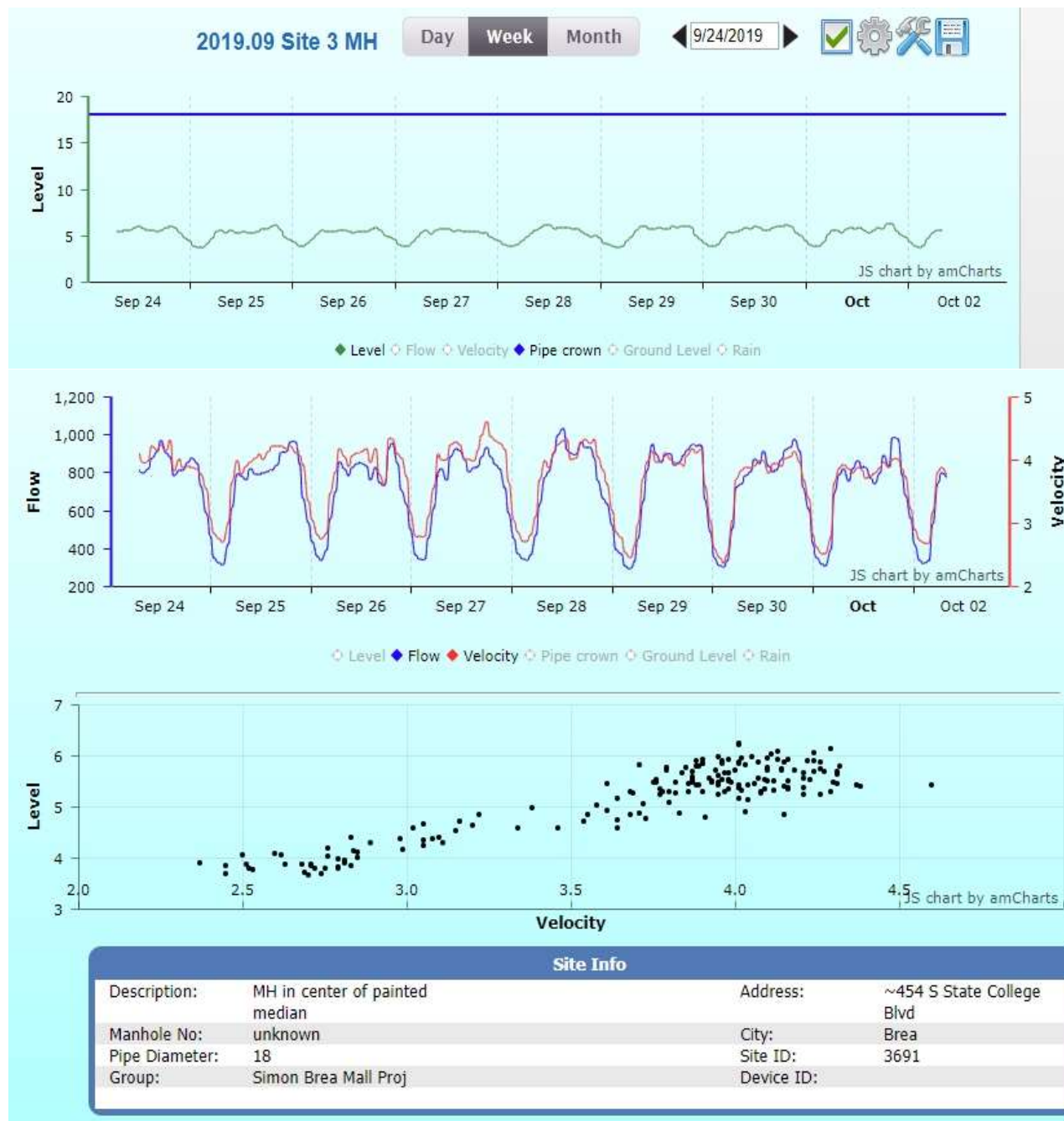


The pipe capacity was estimated using a Manning's Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with the minimum value for a VCP with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for an 8-in pipe with a slope of 2.16%, with the pipe completely full, the velocity should be ~5.1037 fps, which when input into the Flo-Ware program from the Site 2 MH produced a maximum capacity of ~1.1514 mgd.

Site 2 MH Level (depth) vs Pipe Diameter



Figures below: Site 3 MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot above shows the depth vs velocity data points for the 18-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. According to the City as-builts, the slope of the 12-in line upstream from the Site 3 MH should be 0.80%, while the slope of the line downstream from the Site 3 MH (RB66-RA43D) should be 0.63%.

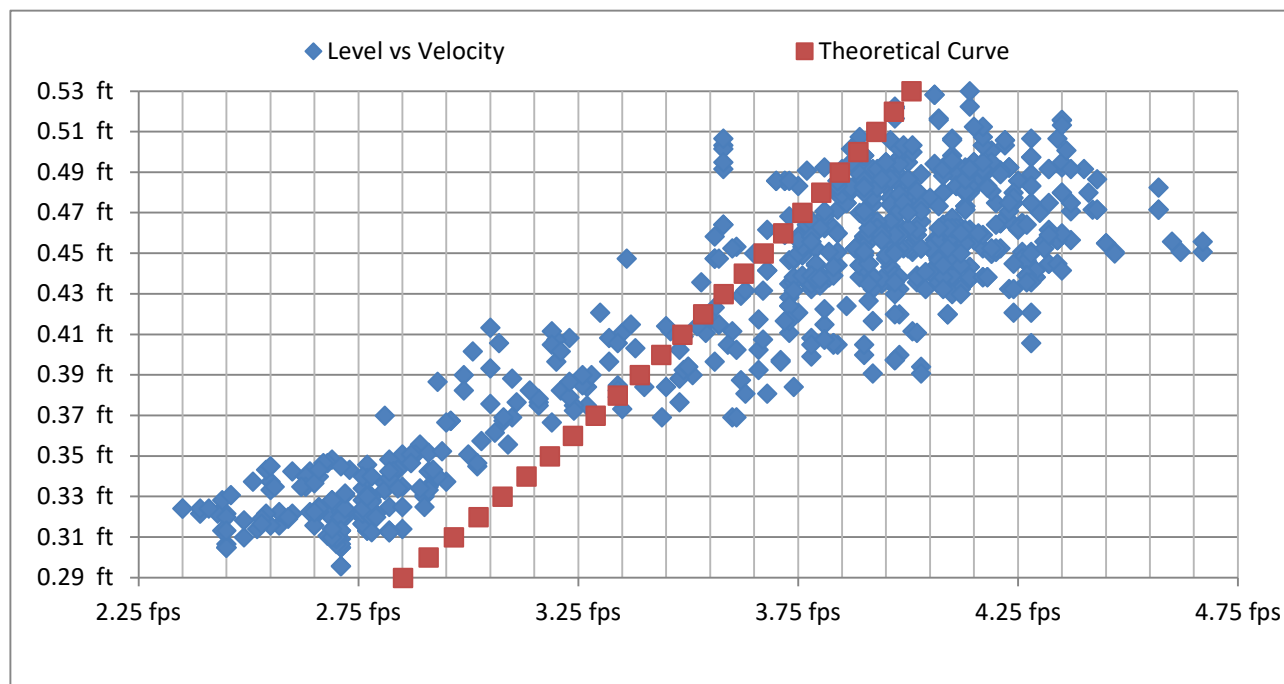


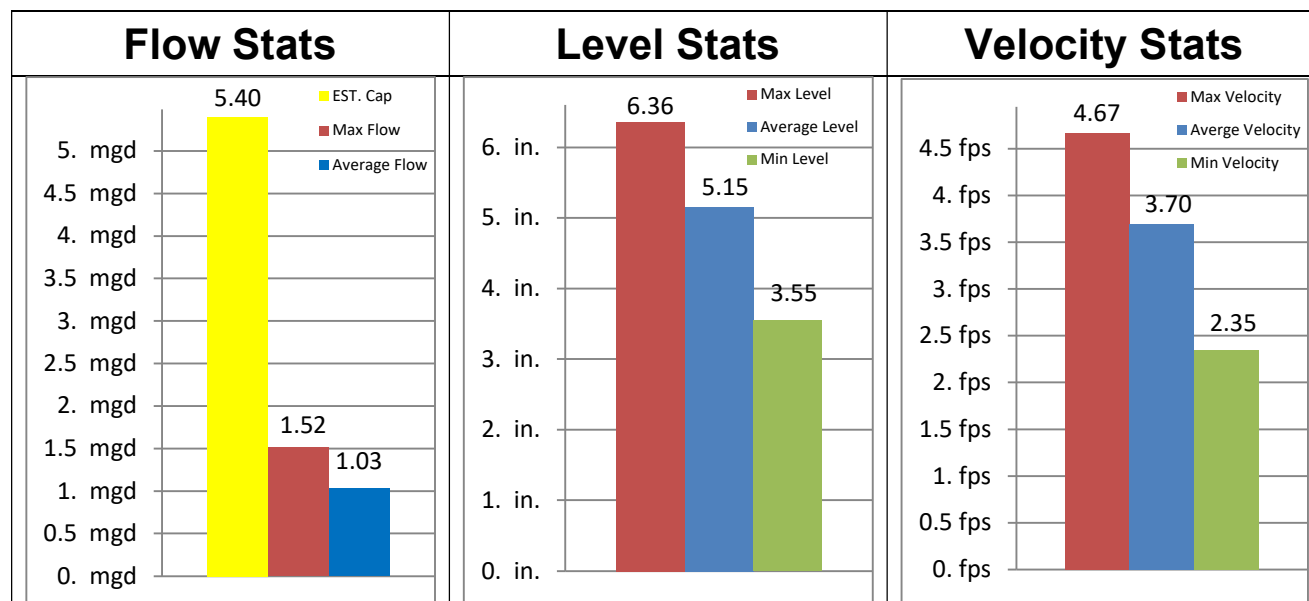
Figure above: Since the flows at the Site 3 MH utilized ~20% to ~36% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, while a majority of the data falls into an acceptable area along the theoretical curve, the level to velocity relationship is slightly skewed at lower levels. This could indicate that some form of blockage is slowing velocities at lower levels, which does not hinder the higher levels. This crossover is between ~4.4 and 5 inches of depth.

To summarize the site statistics from the data analysis at the Site 3 MH:

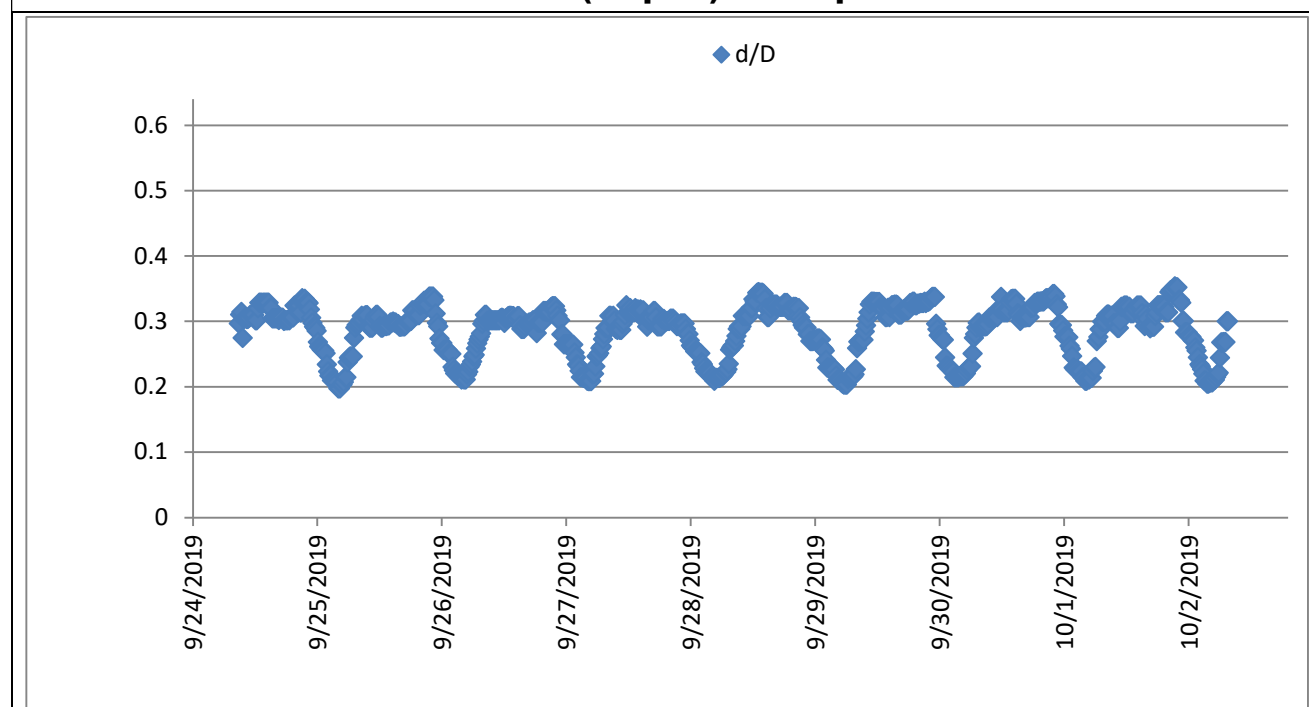
- During peak flows, 1.5150 mgd or ~1052 gpm utilized ~28.0% of the pipe's capacity.
- During average flows, 1.0278 mgd or ~714 gpm utilized ~19.0% of the pipe's capacity.
- The maximum velocity at the Site 3 MH was 4.67 fps with an average velocity of 3.70 fps. Therefore, this site should have no issues with regard to blockage due to settlement of normal system solids.
- According to the Brea Sewer System Management Plan, the depth versus diameter (d/D) ratio for existing collection system pipes of greater than 15 inches in diameter should be no more than 0.64 during dry weather peak flow conditions. The average d/D ratio from the Site 3 MH during this study was ~0.29 and the maximum was ~0.35. Therefore, this 18-in pipe had capacity available during the observed dry weather peak flow.

The following is a graphical representation of the site statistics from the data analysis:

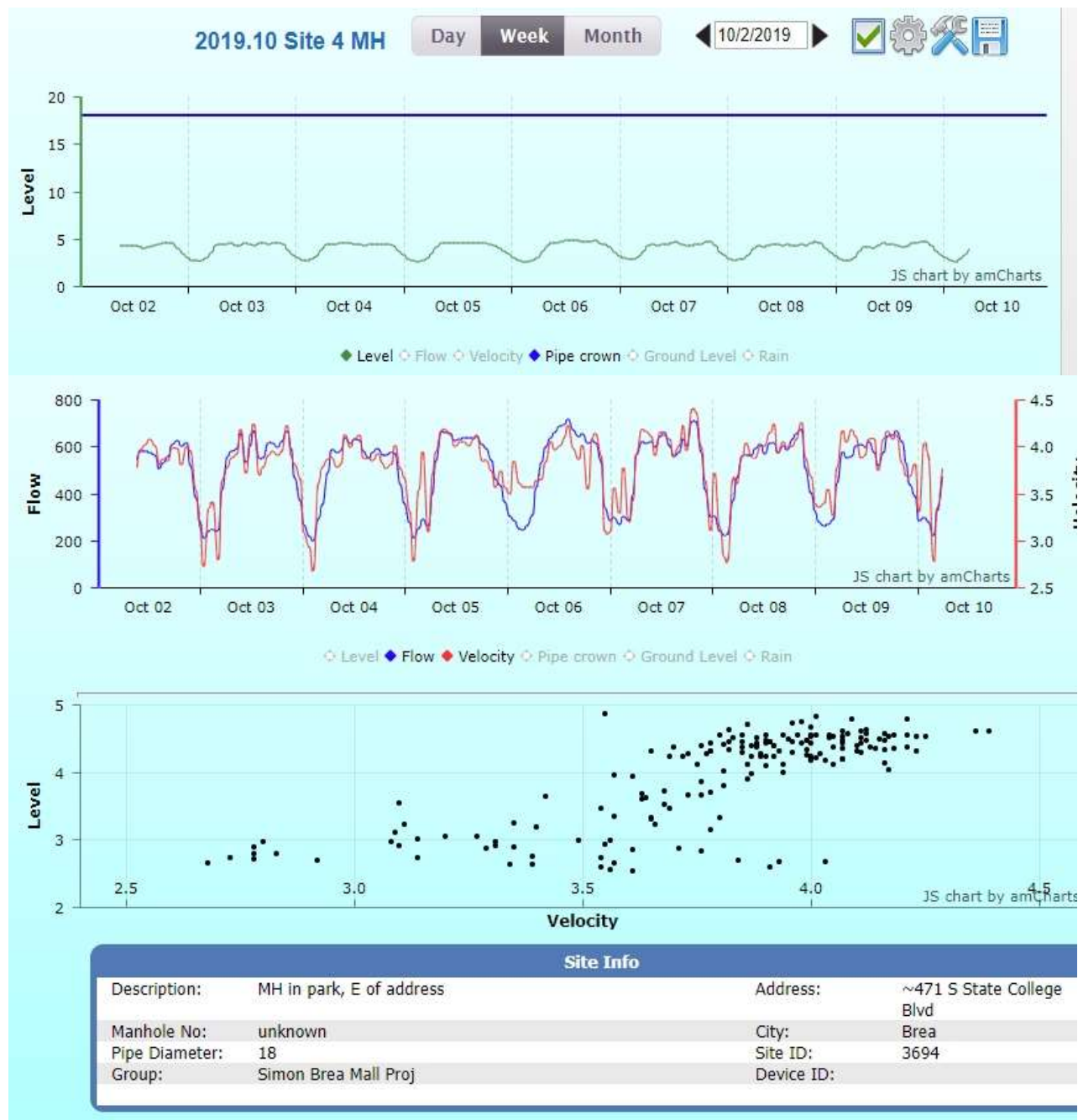


The pipe capacity was estimated using a Manning's Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with the minimum value for a VCP with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for an 18-in pipe with a slope of 0.63%, with the pipe completely full, the velocity should be ~4.7308 fps, which when input into the Flo-Ware program from the Site 3 MH produced a maximum capacity of ~5.4032 mgd.

Site 3 MH Level (depth) vs Pipe Diameter



Figures below: Site 4 MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot above shows the depth vs velocity data points for the 18-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. According to the Birch & State College Mixed-Use Development Sewer Study Technical Memorandum (Tech Memo), dated 10/30/2017 and accepted by the City, the slope of the line downstream from the MH-R-A-43-Drop, which aligns with the location of the Site 4 MH, should be 0.60%.

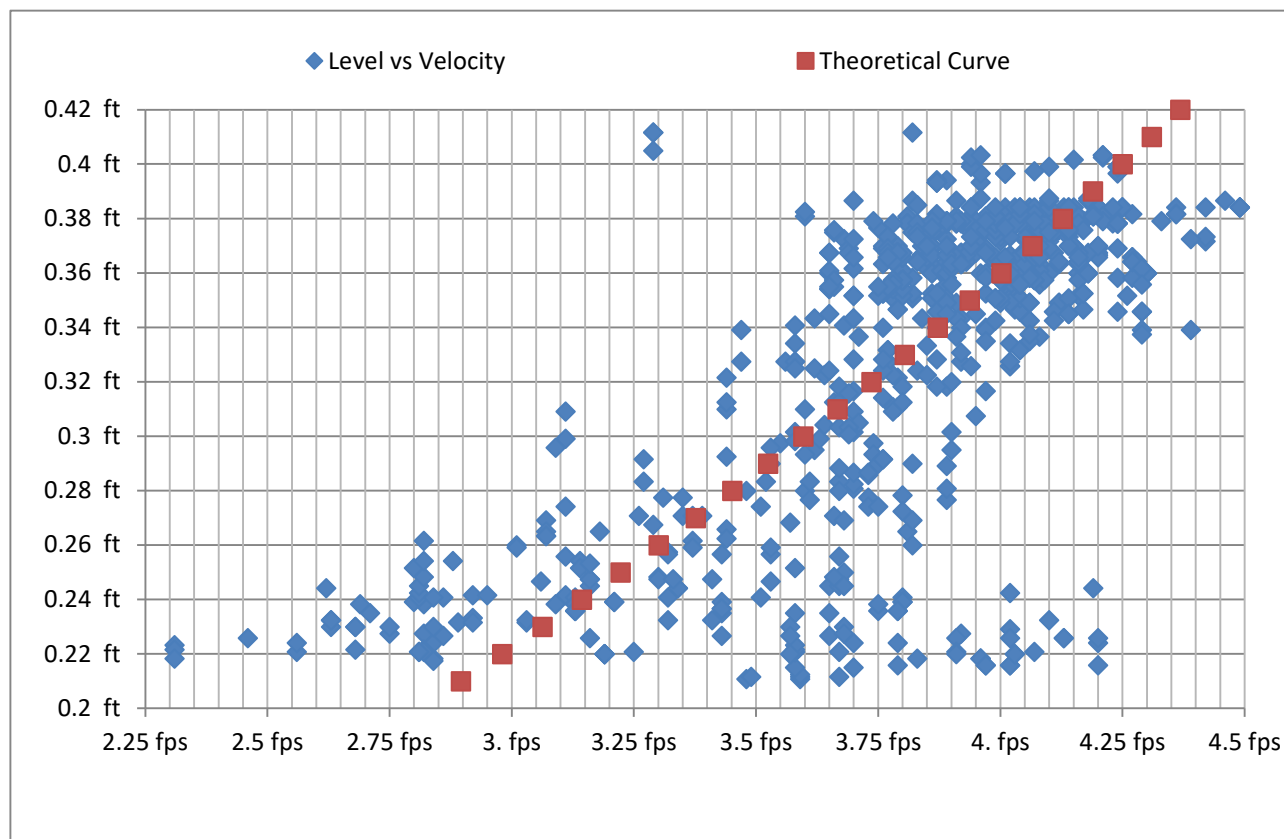


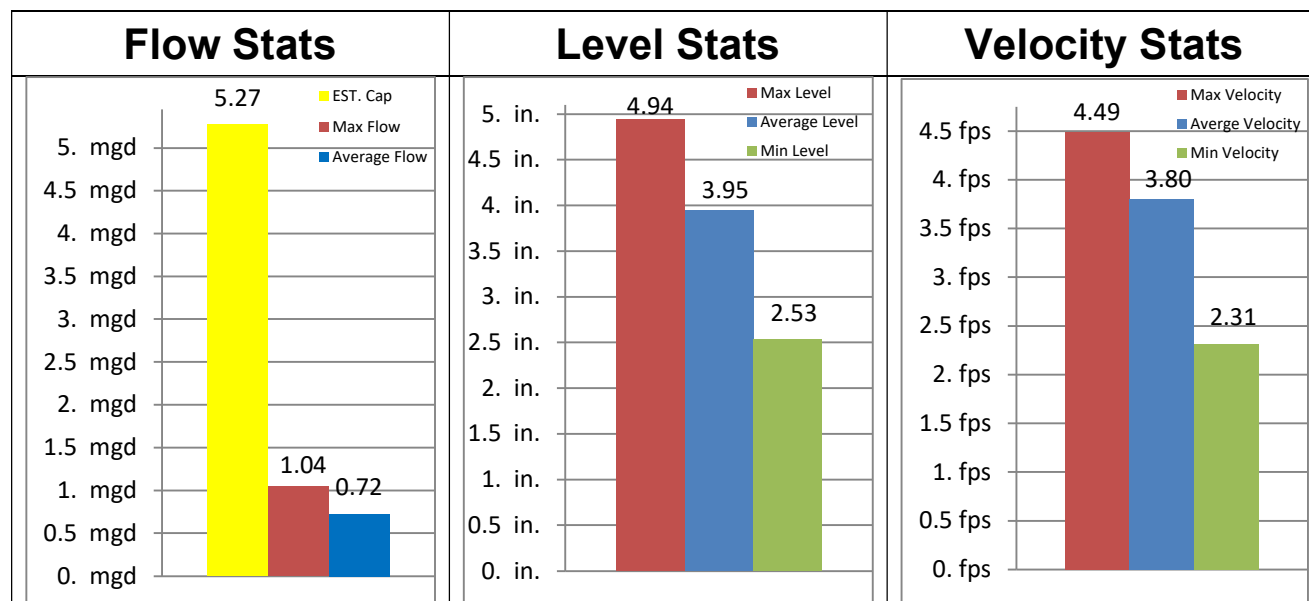
Figure above: Since the flows at the Site 4 MH utilized ~14% to ~27% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, while a majority of the data falls into an acceptable area along the theoretical curve, there are quite a few outliers. In addition, there appears to be a secondary flow pattern at lower levels, which could be flow from the lateral when the mainline flow slows.

To summarize the site statistics from the data analysis at the Site 4 MH:

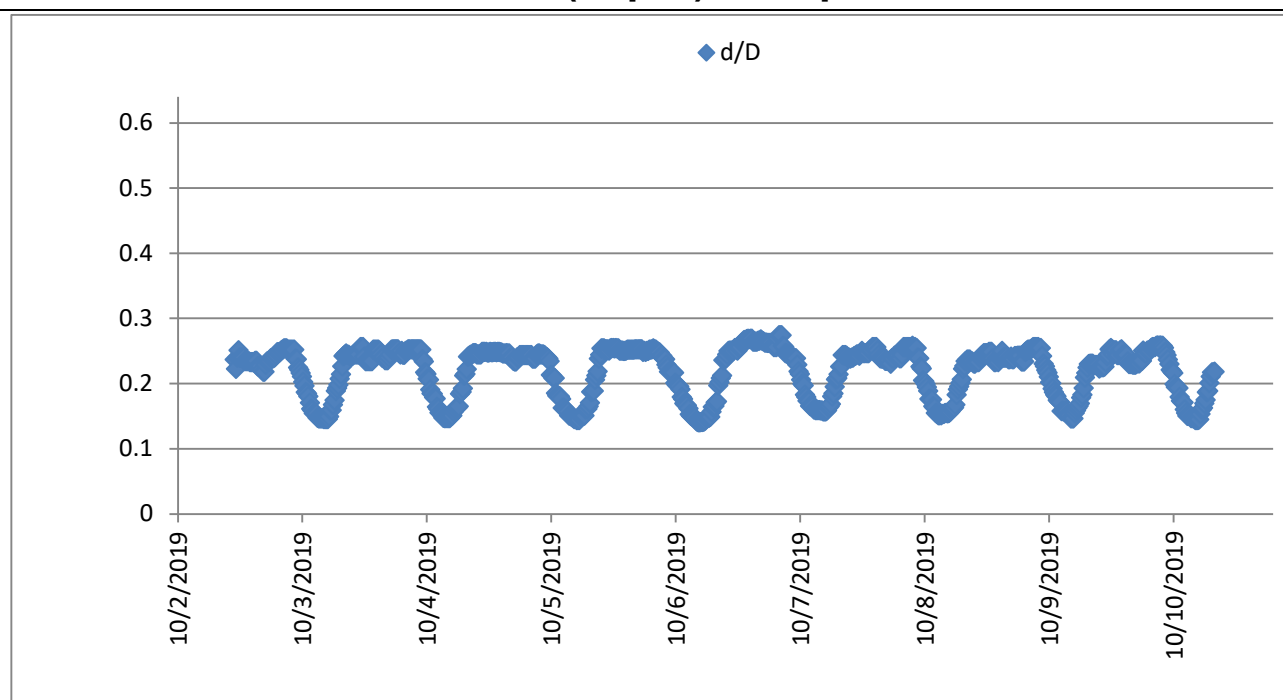
- During peak flows, 1.0417 mgd or ~723 gpm utilized ~19.8% of the pipe's capacity.
- During average flows, 0.7221 mgd or ~501 gpm utilized ~13.7% of the pipe's capacity.
- The maximum velocity at the Site 4 MH was 4.49 fps with an average velocity of 3.80 fps. Therefore, this site should have no issues with regard to blockage due to settlement of normal system solids.
- The average d/D ratio from the Site 4 MH during this study was ~0.22 and the maximum (max) was ~0.27. Therefore, this 18-in pipe had capacity available during the observed dry weather peak flow.

The following is a graphical representation of the site statistics from the data analysis:



The pipe capacity was estimated using a Manning's Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with the minimum value for a VCP with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for an 18-in pipe with a slope of 0.60%, with the pipe completely full, the velocity should be ~4.6168 fps, which when input into the Flo-Ware program from the Site 4 MH produced a maximum capacity of ~5.2730 mgd.

Site 4 MH Level (depth) vs Pipe Diameter



1.6 Proposed Flow Generation

The Brea Mall currently encompasses approximately 1,291,433 square feet (sf) and consists of a central retail core of major department stores (“anchors”). Sears, which was the anchor on the southwest side of the mall, partially closed in April 2018. Therefore, the Simon Property Group is proposing redevelopment of the 17.5-acre Sears parcel, which includes the adjoining transition areas adjacent to Nordstrom and Macy’s. The proposed project involves demolishing the Sears department store and associated auto center (161,990 sf) and 12 acres of surface parking in order to allow a mix of uses.

The project would result in a net increase of commercial space as well as include a residential component. The mean loading used to calculate the proposed average dry weather flow (ADWF) was provided by raSmith, and coordinated with the City of Brea:

- 273.44 gallons per day (gpd) per 1000 sf for the Fitness Center
- 73.5 gpd per 1000 sf for the retail space minus the Sears flow credit
- 210 gpd per dwelling unit for the residential area
- 1575 gpd per 1000 sf for the restaurant

Table 1: Proposed Flow Generation with the Fitness Center

Use Category	Gross Leasable Area/Unit	Mean Loading (gpd/UOU*)	Proposed ADWF (mgd)
Fitness Center	128,000	35,000	0.03500
Sporting Goods	50,000	73.5	0.00368
Brea Mall Shops	34,914	73.5	0.00257
Restaurant	34,501	1,575	0.05434
-Sears Flow Credit	80,500	73.5	0.00592
Total Commercial			0.08967
Residential Units	380	210	0.07980
Total proposed flow			0.16947

* Unit of Use

Peak dry weather flow (PDWF) and peak wet weather flow (PWWF) were calculated using the equations from the Brea Sewer System Management Plan:

$$\text{PDWF} = 1.777 \times \text{Total ADWF}^{0.92}$$

$$\text{PWWF} = 1.25 \times \text{PDWF}$$

Total ADWF shown in Table 2 below is the combination of the average monitored flow and the proposed ADWF from Table 1. In addition, the flow in the new 10-in pipe was included with and without the flow from the Cheesecake Factory, based on the water usage during the time of the monitoring.

59,700 cu. ft of water was used from 9/05/19-10/07/19, which averages ~1867 cu. ft/day

$$1866.67 \text{ cu. ft/day} = 13,963.66 \text{ gpd} = 0.01396366 \text{ mgd}$$

$$0.1021 \text{ mgd} - 0.01396366 \text{ mgd} = 0.088136 \text{ mgd}$$

Table 2: Monitored Average Flows and Proposed Flows Combined

Monitored Site & Site Information ¹	Monitored ADWF (mgd)	Proposed ADWF (mgd)	Total ADWF (mgd)	Calculated PDWF (mgd)	Calculated PWWF (mgd)
New 10-in comm pipe @ 0.46% ²	0.0881	0.08967	0.17781	0.36278	0.45347
New 10-in comm pipe @ 0.46% ³	0.1021	0.08967	0.19177	0.38891	0.48613
New 8-in res pipe @ 1.15%	0	0.07980	0.07980	0.17359	0.21699
Site 1 MH 8-in D/S @ 1.30%	0.1021	0.16947	0.27157	0.53562	0.66953
Site 2 MH 8-in D/S @ 2.16%	0.1211		0.29057	0.57000	0.71251
Site 3 MH 18-in D/S @ 0.63%	1.0278		1.19727	2.09712	2.62141
MH-R-A-43-Drop 18-in D/S @ 0.60%	1.3730		1.54247	2.64757	3.30946

1. The downstream (D/S) line of each manhole was monitored during this study.
2. Upstream of Cheesecake Factory
3. Downstream of Cheesecake Factory

In Section 1.8 of this report, the d/D values will be presented for all reaches downstream of the proposed development. Since the flows from the Tech Memo for MH-R-A-43-Drop are greater than those monitored during this study, they will be used in place of flows from the Site 4 MH.

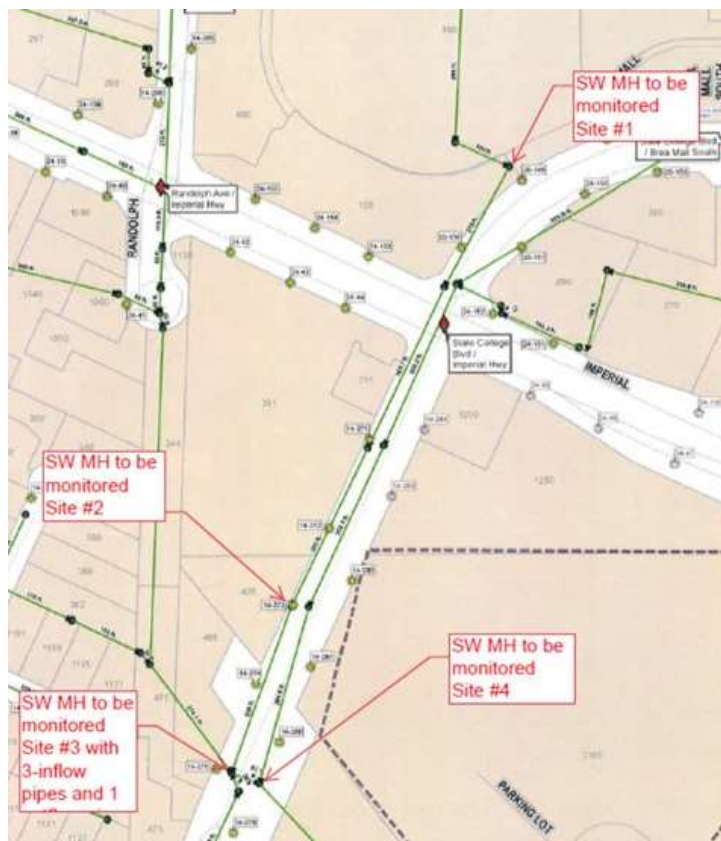
1.7 Flow Monitoring Summary

Calculations in this report are based on steady uniform flow with steady flow defined as the discharge being constant with time, and uniform flow defined as the slope of the water surface and cross-sectional flow area being constant in the length of pipe analyzed. Using velocities from this study in conjunction with the associated cross-sectional areas depicted by the monitored levels, the flow was calculated using the Continuity Equation, and the slope was derived using Manning's Equation.

The flow monitoring equipment at each site was calibrated with regard to site-specific characteristics and manual level and velocity readings for adjustment and verification. Follow-up on the installations confirmed equipment was reading properly at the sites. In addition, all of the equipment went through diagnostic testing before and after the study with less than a 1% deviation between manual and meter level readings and less than a 5% deviation between manual and meter velocity readings. Therefore, equipment calibration was verified in accordance with manufacturer specifications.

Initial flow monitoring for this project began on 09/24/2019 in accord with the supplied sewer map at right. This is also referred to as the first week of monitoring. The Nordstrom MH is not shown but was included in the first week of monitoring.

When the field installation forms and photos were reviewed, it was determined that Site 3 was actually the small line coming up from the southwest and Site 4 was actually Site 3. Therefore, on 10/02/2019, the US³ field team searched the area and found Site 4 in the park, ~50 ft east of the road. Therefore, flow monitoring began at Site 4 at the same time that monitoring was completed at Sites 1, 2 and 3 and at the Nordstrom MH.



2019.09 Nordstrom MH: The graphs for this 8-in sewer line showed a fairly consistent daily flow pattern. In addition, velocities exceeded the minimum requirements to provide sufficient scouring action for self-cleaning as well as providing good capacity within the line. As previously stated, the utility plans showed the downstream slope for this section of sewer line to be 1.70%.

Therefore, in order to determine the maximum allowable flow within the pipe segment downstream of the Nordstrom MH, the plan slope (1.70%) was used to generate a theoretical hydraulic operating curve for the 8-in pipe. At half pipe (4 inches), the velocity from the theoretical curve was ~4.5258 fps, which when input into the Flo-Ware program from the Nordstrom MH produced an expected capacity of ~0.5105 mgd. Since peak flow was 0.1090 mgd, there should be capacity available for an additional 0.4015 mgd before the pipe exceeds its d/D limit of 0.50 at peak flow.

2019.09 Site 1 MH: The graphs for this site showed a fairly consistent daily flow pattern, but the level to velocity relationship could indicate a hydraulic issue within this confluence. In addition, velocities only met the minimum requirements to provide sufficient scouring action for self-cleaning on five days during this 9-day study. As previously stated, the utility plans showed the downstream slope for this section of sewer line to be 1.30%.

In order to determine the maximum allowable flow within the pipe segment downstream of the Site 1 MH, the plan slope (1.30%) was used to generate a theoretical hydraulic operating curve for the 8-in pipe. At half pipe (4 inches), the velocity from the theoretical curve was ~3.9577 fps, which when input into the Flo-Ware program from the Site 1 MH produced an expected capacity of ~0.4464 mgd. Since peak flow was 0.2194 mgd, there should be capacity available for an additional 0.2270 mgd before the pipe exceeds its d/D limit of 0.50 at peak flow.

2019.09 Site 2 MH: The graphs for this site showed a fairly consistent daily level, but the velocities did not follow any observable pattern. This resulted in a data set resembling a cloud formation, which is indicative of processed or non-conforming flow. However, velocities did exceed the minimum requirements for self-cleaning as well as providing good capacity within the line. As previously stated, the utility plans showed the slope of the line upstream from the Site 2 MH (RB6602-RB6601) to be 3.0%, while the slope of the line downstream from the Site 2 MH (RB6601-RB66) to be 2.16%.

In order to determine the maximum allowable flow within the pipe segment downstream of the Site 2 MH, the plan slope (2.16%) was used to generate a theoretical hydraulic operating curve for the 8-in pipe. At half pipe (4 inches), the velocity from the theoretical curve was ~5.1015 fps, which when input into the Flo-Ware program from the Site 2 MH produced an expected capacity of ~0.5755 mgd. Since peak flow was 0.1798 mgd, there should be

capacity available for an additional 0.3957 mgd before the pipe exceeds its d/D limit of 0.50 at peak flow.

2019.09 Site 3 MH: This site was originally believed to be the Site 4 MH, but was actually the Site 3 MH. The graphs for this site showed a fairly consistent daily flow pattern. In addition, velocities exceeded the minimum requirements for self-cleaning as well as providing good capacity within the line. As previously stated, the City as-builts showed the slope of the 12-in line upstream from the Site 3 MH to be 0.80%, while the slope of the 18-in downstream line from the Site 3 MH (RB66-RA43D) to be 0.63%.

In order to determine the maximum allowable flow within the pipe segment downstream of the Site 3 MH, the slope (0.63%) was used to generate a theoretical hydraulic operating curve for the 18-in pipe. At the d/D limit (11.52 inches), the velocity from the theoretical curve was ~5.1775 fps, which when input into the Flo-Ware program from the Site 3 MH produced an expected capacity of ~3.9969 mgd. Since peak flow was 1.5150 mgd, there should be capacity available for an additional 2.4819 mgd before the pipe exceeds its d/D limit of 0.64 at peak flow.

2019.09 Site 3A MH: This site was originally believed to be the Site 3 MH, but was actually determined to be a brine line. Since this was not one of the required monitoring sites, no data analysis was performed on the data.

Second Week of Monitoring

2019.09 Site 4 MH: On 10/02/2019, the US³ field team searched the area and found this site in the park, ~50 ft east of the road. Therefore, flow monitoring began at the Site 4 MH at the same time that monitoring was completed at the other four sites.

The graphs for the Site 4 MH showed a fairly consistent daily level. The velocity readings were not as consistent as the level readings, but the overall level to velocity relationship was not bad. In addition, velocities exceeded the minimum requirements for self-cleaning as well as providing good capacity within the line. The Tech Memo showed the slope for the MH-R-A-43-Drop downstream line, which aligns with the location of the Site 4 MH, to be 0.60%.

In order to determine the maximum allowable flow within the pipe segment downstream of the Site 4 MH, the Tech Memo slope (0.60%) was used to generate a theoretical hydraulic operating curve for the 18-in pipe. At the d/D limit (11.52 inches), the velocity from the theoretical curve was ~5.0527 fps, which when input into the Flo-Ware program from the Site 4 MH produced an expected capacity of ~3.9006 mgd. Since peak flow was 1.0417 mgd, there should be capacity available for an additional 2.8589 mgd before the pipe exceeds its d/D limit of 0.64 at peak flow.

The first week of flow monitoring at the Nordstrom MH and the Site 1, 2 and 3 MHs was completed on 10/02/2019, which is when the second week of flow monitoring began at the Site 4 MH and was completed on 10/10/2019.

It was noted that the flows decreased at the Site 4 MH during the second week of monitoring when compared to the Site 3 MH during the first week of monitoring. It is not unusual for flows to change from week to week for many different reasons. Unfortunately, no additional information can be provided as to the causes.

1.8 Proposed Mitigation

For the City of Brea's service area, all new pipe 15-in and smaller shall be designed so that the d/D ratio at PDWF shall not exceed 0.5. This ratio shall not exceed 0.64 for 18-in and larger pipes. The PWWF is estimated at 1.25 times the PDWF, and the d/D ratio at PWWF is not to exceed 0.75.

The Brea Mall Mixed Use Project proposes to replace the existing onsite 8-in sewer line on the downstream side of the Nordstrom MH. In the proposed redevelopment (Table 1), the new 10-in line will carry existing and proposed commercial flow, which will include a fitness center. This new 10-in sewer line may also pick up the flow from the existing restaurant (Cheesecake Factory) located on the northwest corner of S. State College Blvd and Imperial Hwy prior to discharging to the existing 8-in sewer line at a new manhole, which will be constructed downstream from the Site 1 MH.

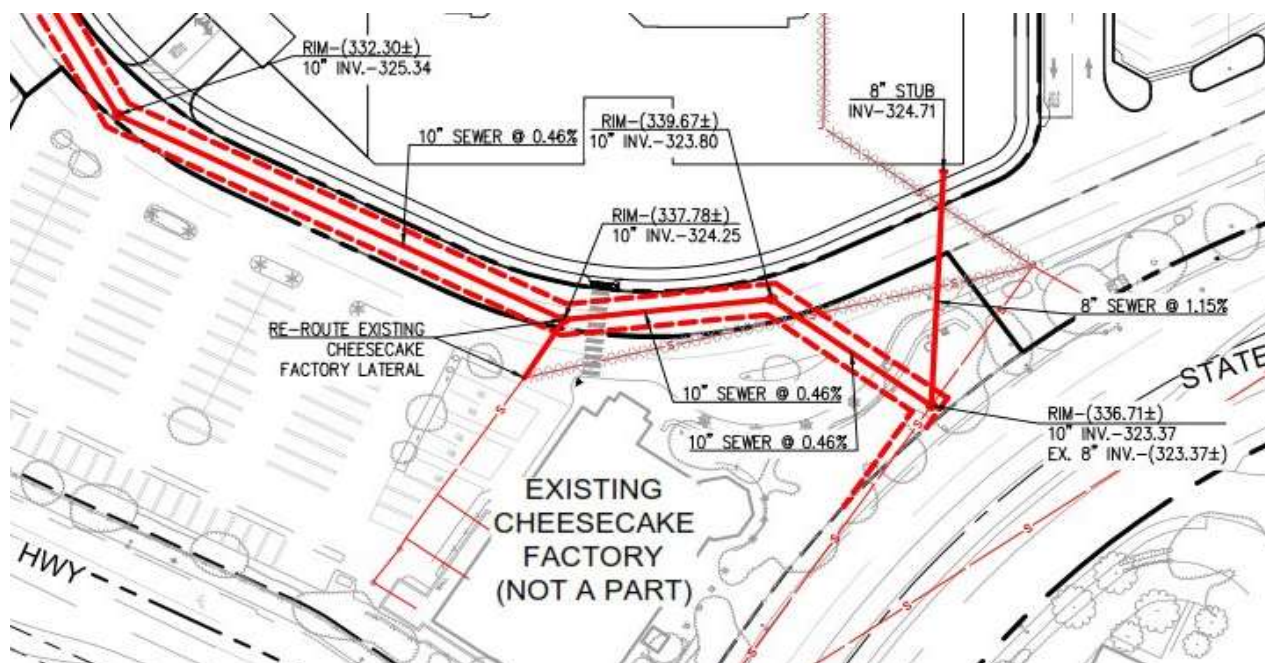


Figure above: Sewer map showing proposed connections of the new onsite sewer lines to the existing offsite sewer line at a new manhole southwest of the Site 1 MH.

The placement of the new manhole will allow the onsite sewer lines to tie into the existing 8-in sewer line at a better angle, thereby improving hydraulics in the line and in the Site 1 MH. A second new onsite 8-in sewer line will be carrying only the proposed flow from the residential area on the south end of the property. This sewer line will also tie into the existing 8-in sewer line at the new manhole downstream from the Site 1 MH.

The total PDWF of the new 10-in line will be 0.388907 mgd and the PWWF will be 0.486134 mgd. If the Cheesecake Factory flow is connected to the existing 8-in sewer line separately, the total PDWF of the new 10-in line will be 0.36278 mgd and the PWWF will be 0.45347 mgd. Both scenarios are shown in Table 2 on page 33 of this report.

The southern residential area will have its own dedicated 8-in sewer line, which will have a slope of 1.15%. The total PDWF of the new 8-in line will be 0.17359 mgd and the PWWF will be 0.21699 mgd as shown in Table 2.

When the new 10-in onsite sewer line ties into the line coming from the Nordstrom MH, the slope will be 1.00%. As it crosses the remainder of the property, the slope of the line will drop. According to the proposed onsite sewer design, the minimum slope of the new 10-in line will be 0.46%. Therefore, this minimum slope was used in the capacity analysis.

In order to evaluate the effect that the proposed development will have on the City's public sewer system, all reaches downstream of the proposed development have been included in Table 3 on page 40 of this report. The City's capacity analysis format has been used to show the d/D design criteria for all existing and proposed pipes in Table 3. This table shows that the existing flow plus the proposed project flow will exceed the City PDWF and PWWF d/D criteria within two sewer line segments within the public right-of-way (MH RB6604 to MH RB6603 and MH RB6603 to MH RB6602). Therefore, as a recommended mitigation measure for these pipe segments, Smart Covers could be installed on MH RB6602 and MH RB6604 in order to notify the City in the case there is a backup within these sewer segments that do not meet the design criteria.

A sewer map has been included on the following page, which references the City MH ID in conjunction with the sewer study monitoring location names as well as the pipe sizes, slopes and pipe lengths for cross-reference.

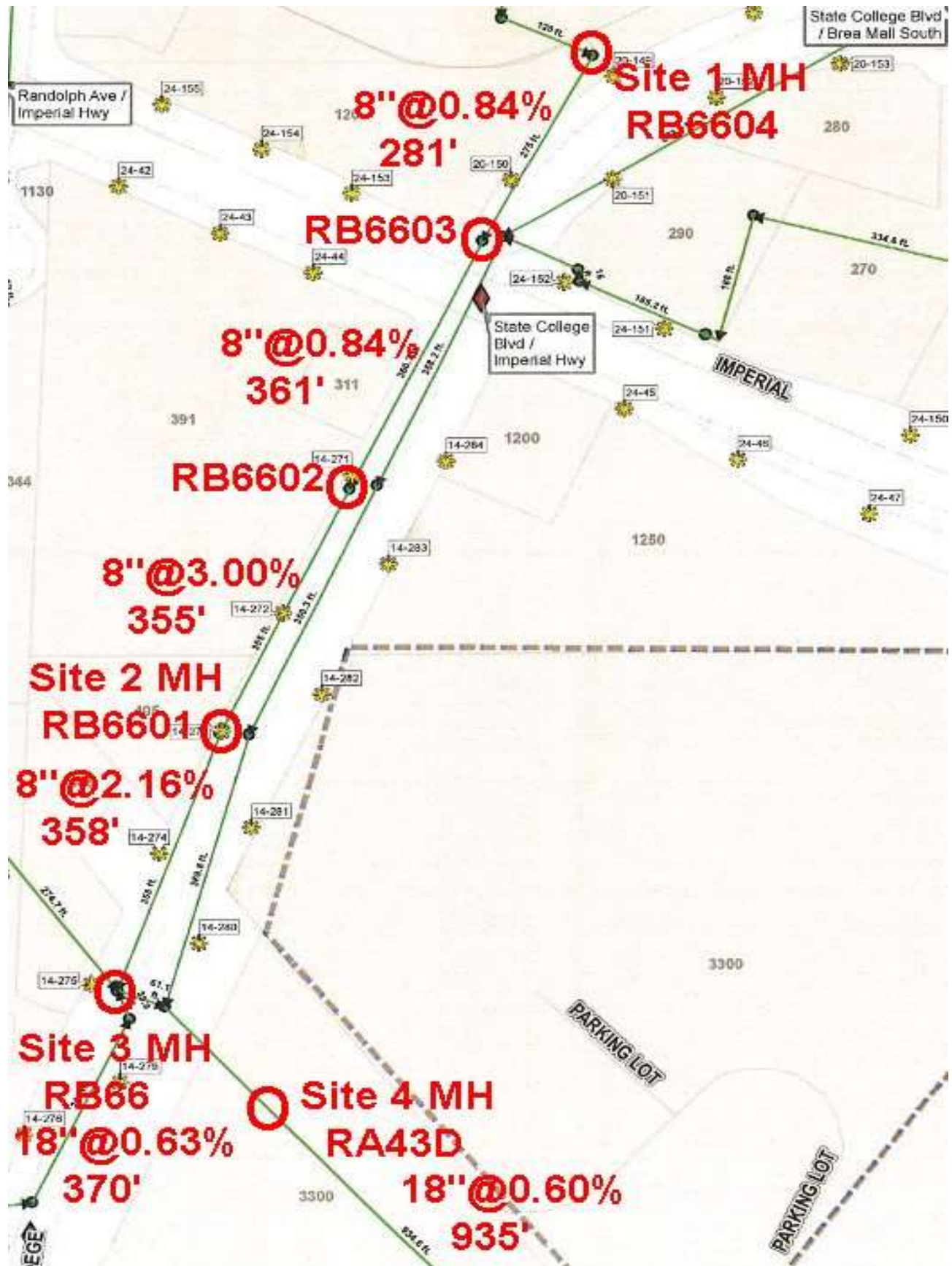


Table 3: Capacity Analysis of Proposed Onsite Pipes & Existing Offsite Pipes for the Proposed Brea Mall Mixed Use Project

General Information						Hydraulic Analysis Results								
Pipe	U/S MH ID	D/S MH ID	Dia (in)	Length (ft)	Slope	Total ADWF (mgd)	PDWF (mgd)	PDWF Vel (fps)	PDWF d/D	PDWF Depth (ft)	PWWF (mgd)	PWWF Vel (fps)	PWWF d/D	PWWF Depth (ft)
Proposed Onsite Line ¹			10	1375	0.0046	0.17781	0.36278	2.5392	0.43	0.354449	0.45347	2.6909	0.48	0.402302
Proposed Onsite Line ²			10	1375	0.0046	0.19177	0.38891	2.5862	0.44	0.368510	0.48613	2.7384	0.50	0.419022
Proposed Onsite Line ³			8	360	0.0115	0.07980	0.17359	2.9336	0.31	0.205673	0.21699	3.1227	0.35	0.231181
DS of Site 1	RB6604	RB6603	8	281	0.0084	0.27157	0.53562	3.4879	0.64	0.429271	0.66953	3.6154	0.77	0.511068
DS of MH ⁴	RB6603	RB6602	8	361	0.0084	0.27157	0.53562	3.4894	0.64	0.429910	0.66953	3.6147	0.77	0.510087
US of Site 2	RB6602	RB6601	8	355	0.0300	0.29057	0.57000	5.7397	0.45	0.301966	0.71251	6.0740	0.52	0.343781
DS of Site 2	RB6601	RB66	8	358	0.0216	0.29057	0.57000	5.0894	0.50	0.331465	0.71251	5.3712	0.57	0.379553
DS of Site 3	RB66	RA43D	18	370	0.0063	1.19727	2.09712	4.4320	0.43	0.648715	2.62141	4.6951	0.49	0.736852
DS of Site 4	RA43D	Outletr	18	935	0.0060	1.54247	2.64757	4.6216	0.50	0.751853	3.30946	4.8761	0.57	0.861438

1. New 10-in sewer pipe with existing & proposed commercial flows using the minimum design slope without the Cheesecake Factory flow
2. New 10-in sewer pipe with existing & proposed commercial flows using the minimum design slope with the Cheesecake Factory flow
3. New onsite 8-in sewer pipe with only proposed residential flow
4. First MH on State College Blvd, south of Imperial Hwy

Tab 2: Calibration Site Sheets & Flo-Ware Graphs



raSmith

MH at ~1048 Brea Mall

Brea, CA 92821

2019.09 Nordstrom MH

MH # unknown

Access:

MH in left-hand NB lane, E of parking structure

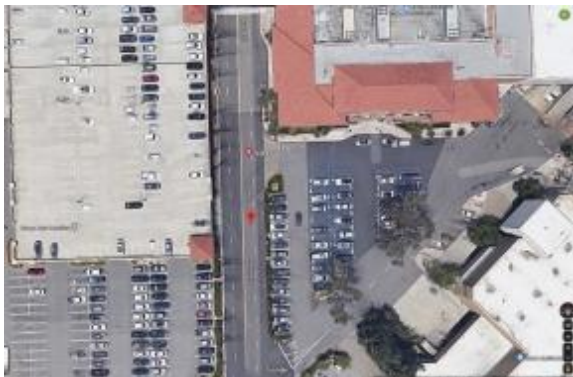
System Type:

Sanitary ☒

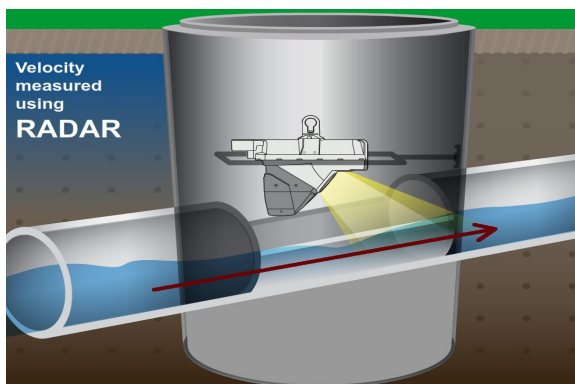
Storm ☐

Install Date: 9/24/2019

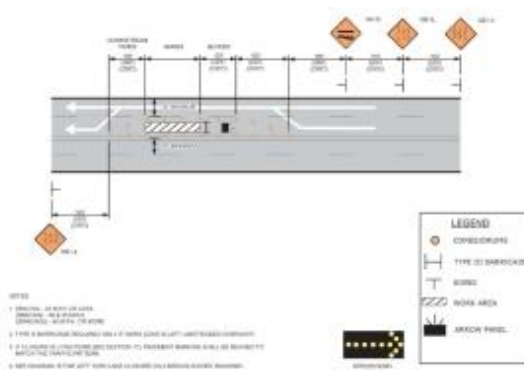
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 67"

MH Coordinates: 33.915117, -117.888619

Moderate open channel hydraulics

Avg Velocity	Avg Measured Level	Multiplier
2.75 fps	1.0"	1.0

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

No laterals; monitored the downstream line as it provided the best hydraulics.

Traffic Safety

No formal TCP required; used cones & signs per WATCH Diagram 15 requirements.

Land Use

Residential	Commercial	Industrial	Trunk
	X		

Manhole Depth	81"
Monitored Pipe Size	8"
Inner Pipe Size (In/Out)	8"/8"
Pipe Shape	Round
Pipe Condition	Fair
Manhole Material	Concrete
Silt	0
Velocity Profile Data	*
Velocity Profile Taken	0.4 2-D
Sensor Offset	14.09"
Sensor Dist. to Crown	6.09"
Sensor Direction	Downstream
Flow Heading	South



Meter Site Document

2019.09 Nordstrom MH

MH at ~1048 Brea Mall

Brea, CA 92821

Site



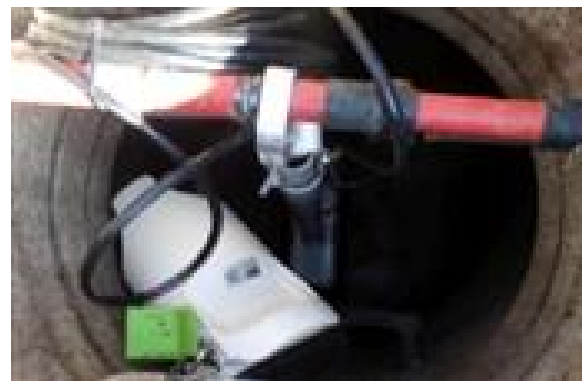
Manhole Before Install



Installation Process



Installed



Downstream Pipe Size



Downstream





Water Science and Software

Report Date: 11/11/2011

Location: S 100

Project: S 100 on S 100 M 100

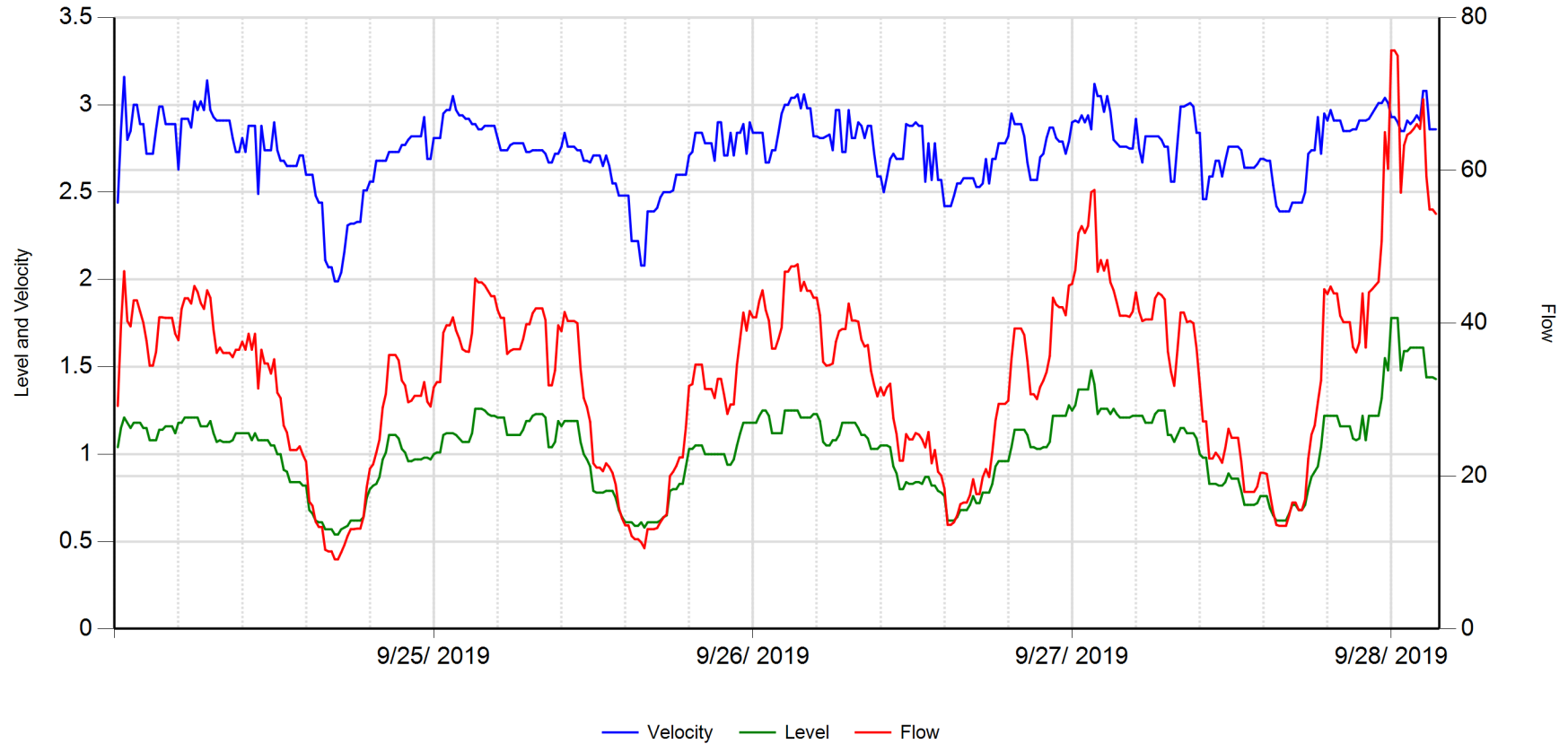
Site: S 100 on S 100 M 100

Summary for S 100 on S 100 M 100

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
11/11/2011	34.03	75.69	9.10	0.05	0.11	0.01	2.77	3.16	1.99	1.04	1.78	0.54	294,010	
11/12/2011	27.29	47.01	7.43	0.04	0.07	0.01	2.62	3.07	1.69	0.91	1.26	0.53	117,912	
11/13/2011	31.78	75.69	7.43	0.05	0.11	0.01	2.72	3.16	1.69	0.99	1.78	0.53	411,922	
Week:	34.03	75.69	9.10	0.05	0.11	0.01	2.77	3.16	1.99	1.04	1.78	0.54	294,010	
11/14/2011	27.29	47.01	7.43	0.04	0.07	0.01	2.62	3.07	1.69	0.91	1.26	0.53	117,912	
11/15/2011	31.78	75.69	7.43	0.05	0.11	0.01	2.72	3.16	1.69	0.99	1.78	0.53	411,922	
Week:	27.29	47.01	7.43	0.04	0.07	0.01	2.62	3.07	1.69	0.91	1.26	0.53	117,912	
Totals:	31.78	75.69	7.43	0.05	0.11	0.01	2.72	3.16	1.69	0.99	1.78	0.53	411,922	

Page 1 of 1

2019.09 Nordstrom MH

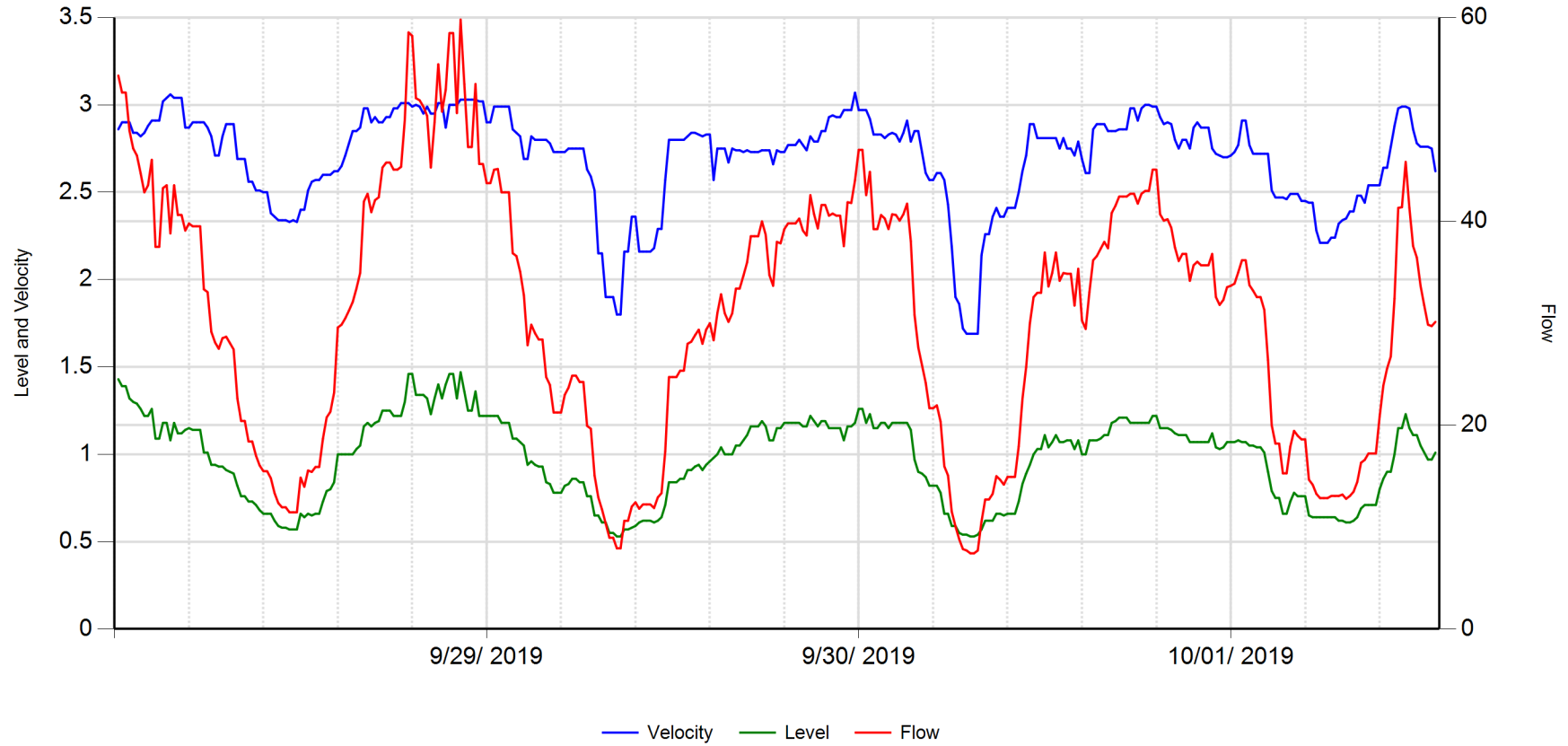


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	2.745	1.028	33.426	RainFall	Inches
Maximum	3.160	1.780	75.694		
Minimum	1.990	0.540	9.097		



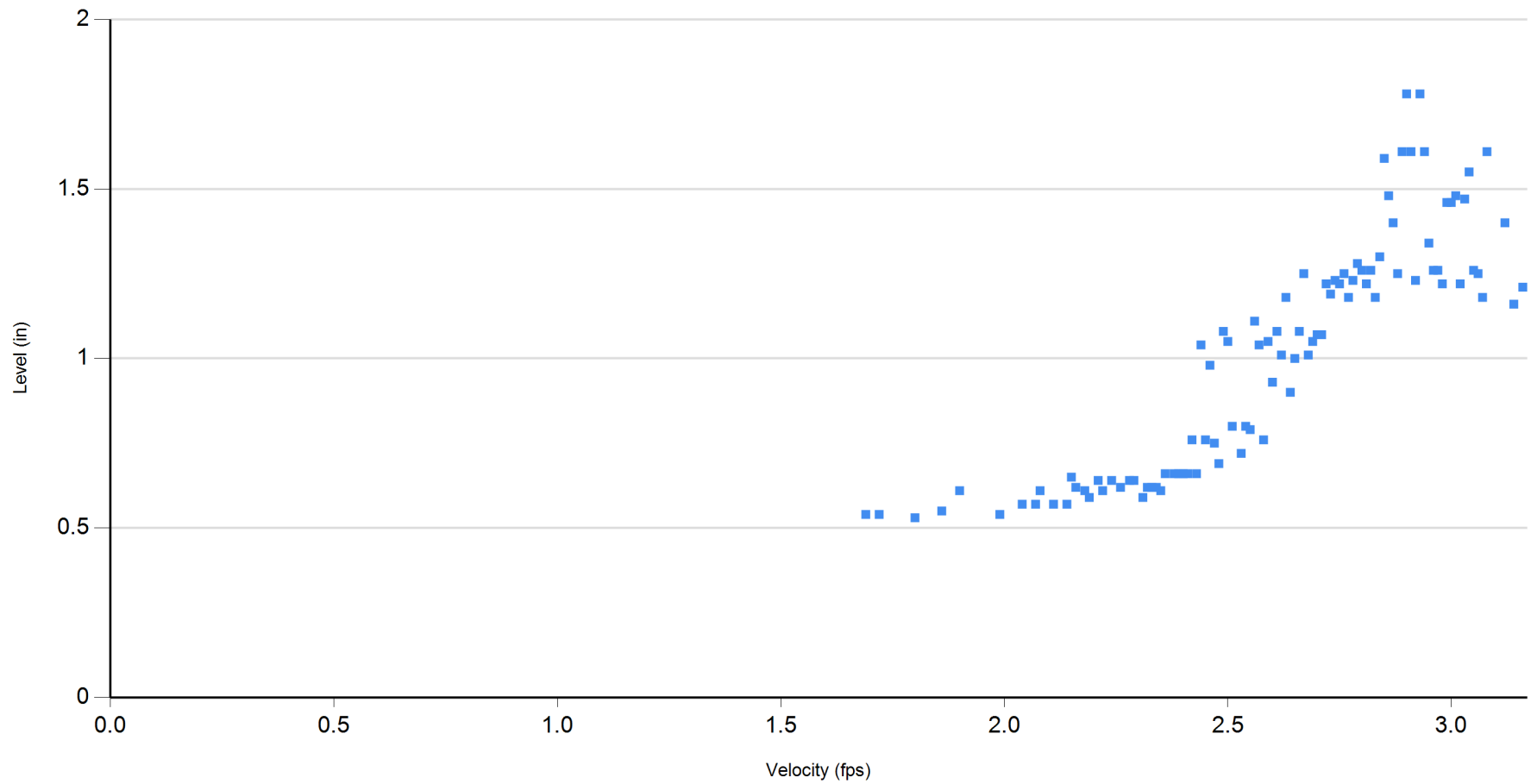
10/14/2019

2019.09 Nordstrom MH



	Velocity (fps)	Level (in)	Flow (gpm)			
Average	2.698	0.974	30.806	RainFall	Inches	
Maximum	3.070	1.470	59.791			
Minimum	1.690	0.530	7.431			

2019.09 Nordstrom MH



09/24/2019 thru 10/02/2019



10/14/2019 11:06:49 AM



raSmith

MH at ~120 Brea Mall

Brea, CA 92821

2019.09 Site 1 MH

MH # unknown

Access:

MH on sidewalk, NE of Cheesecake Factory

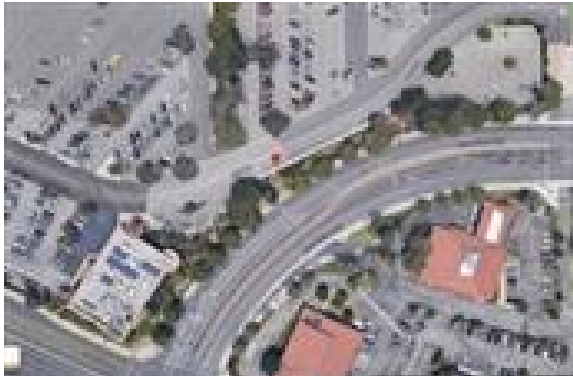
System Type:

Sanitary ☒

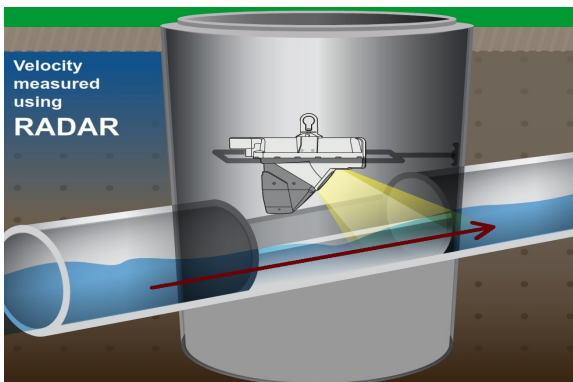
Storm ☐

Install Date: 9/24/2019

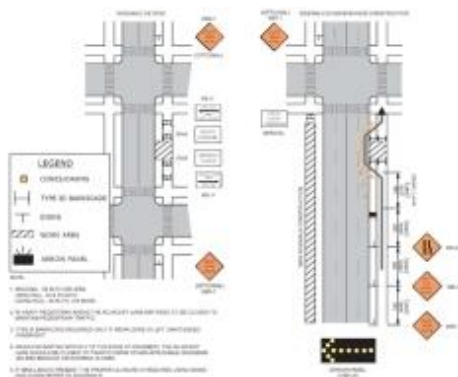
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 188"

MH Coordinates: 33.912802, -117.887424

Moderate open channel hydraulics with turbulence due to inflow from lateral

Avg Velocity	Avg Measured Level	Multiplier
1.66 fps	2.5"	1.0

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

Two inlets from west & north, eastern line plugged; monitored downstream line to get total flow.

Traffic Safety

No formal TCP required; used cones & signs per WATCH Diagram 2 requirements.

Land Use

Residential	Commercial	Industrial	Trunk
	X		

Manhole Depth	202"
Monitored Pipe Size	8"
Inner Pipe Size (In/Out)	8"/8"
Pipe Shape	Round
Pipe Condition	Fair
Manhole Material	Concrete
Silt	0
Velocity Profile Data	*
Velocity Profile Taken	0.4 2-D
Sensor Offset	13.90"
Sensor Dist. to Crown	5.90"
Sensor Direction	Downstream
Flow Heading	South



Meter Site Document

2019.09 Site 1 MH

MH at ~120 Brea Mall

Brea, CA 92821

Site



Manhole Before Install



Installation Process



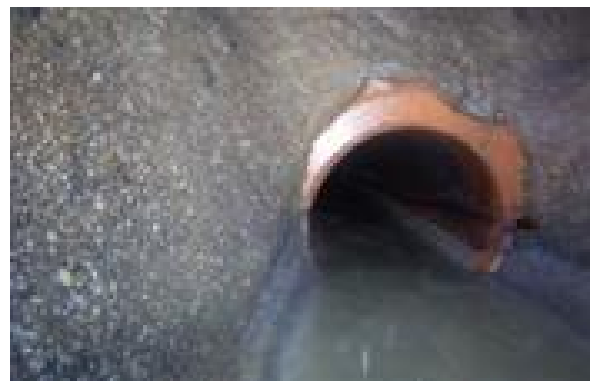
Line From East Plugged



Downstream Pipe Size



Downstream





Water Science and Software

Report Date: 11/11/2011

Location: S 100

Project: S 100 on S 100 M 100

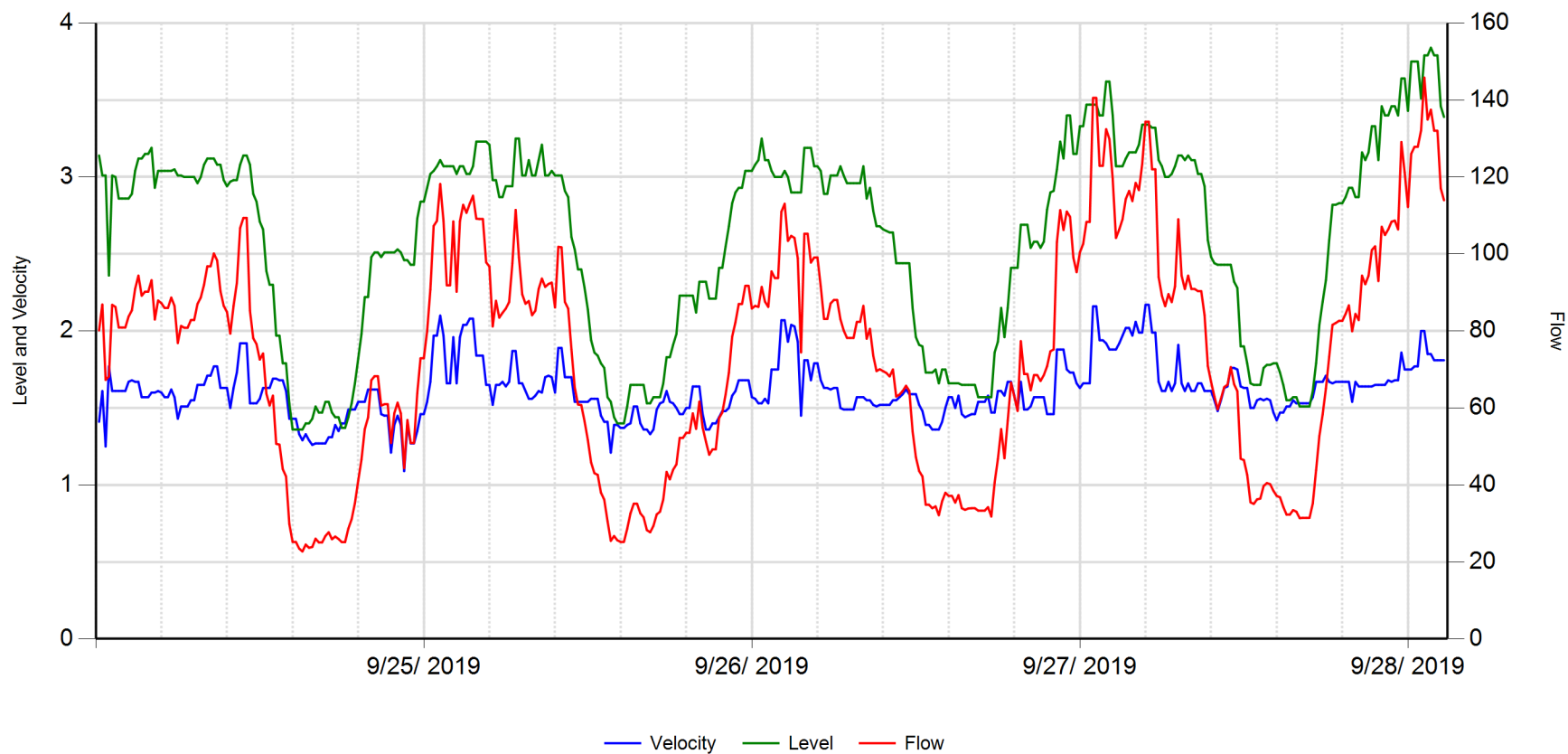
Site: S 100 M 100

Summary for S 100 M 100

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
11/11/2011	76.57	152.36	22.71	0.11	0.22	0.03	1.63	2.43	1.09	2.64	3.84	1.36	661,590	
11/12/2011	55.35	114.10	21.39	0.08	0.16	0.03	1.51	1.82	1.25	2.21	3.37	1.33	239,127	
11/13/2011	69.50	152.36	21.39	0.10	0.22	0.03	1.59	2.43	1.09	2.50	3.84	1.33	900,717	
Week:	76.57	152.36	22.71	0.11	0.22	0.03	1.63	2.43	1.09	2.64	3.84	1.36	661,590	
11/14/2011	55.35	114.10	21.39	0.08	0.16	0.03	1.51	1.82	1.25	2.21	3.37	1.33	239,127	
11/15/2011	69.50	152.36	21.39	0.10	0.22	0.03	1.59	2.43	1.09	2.50	3.84	1.33	900,717	
Week:	55.35	114.10	21.39	0.08	0.16	0.03	1.51	1.82	1.25	2.21	3.37	1.33	239,127	
Totals:	69.50	152.36	21.39	0.10	0.22	0.03	1.59	2.43	1.09	2.50	3.84	1.33	900,717	

Page 1 of 1

2019.09 Site 1 MH

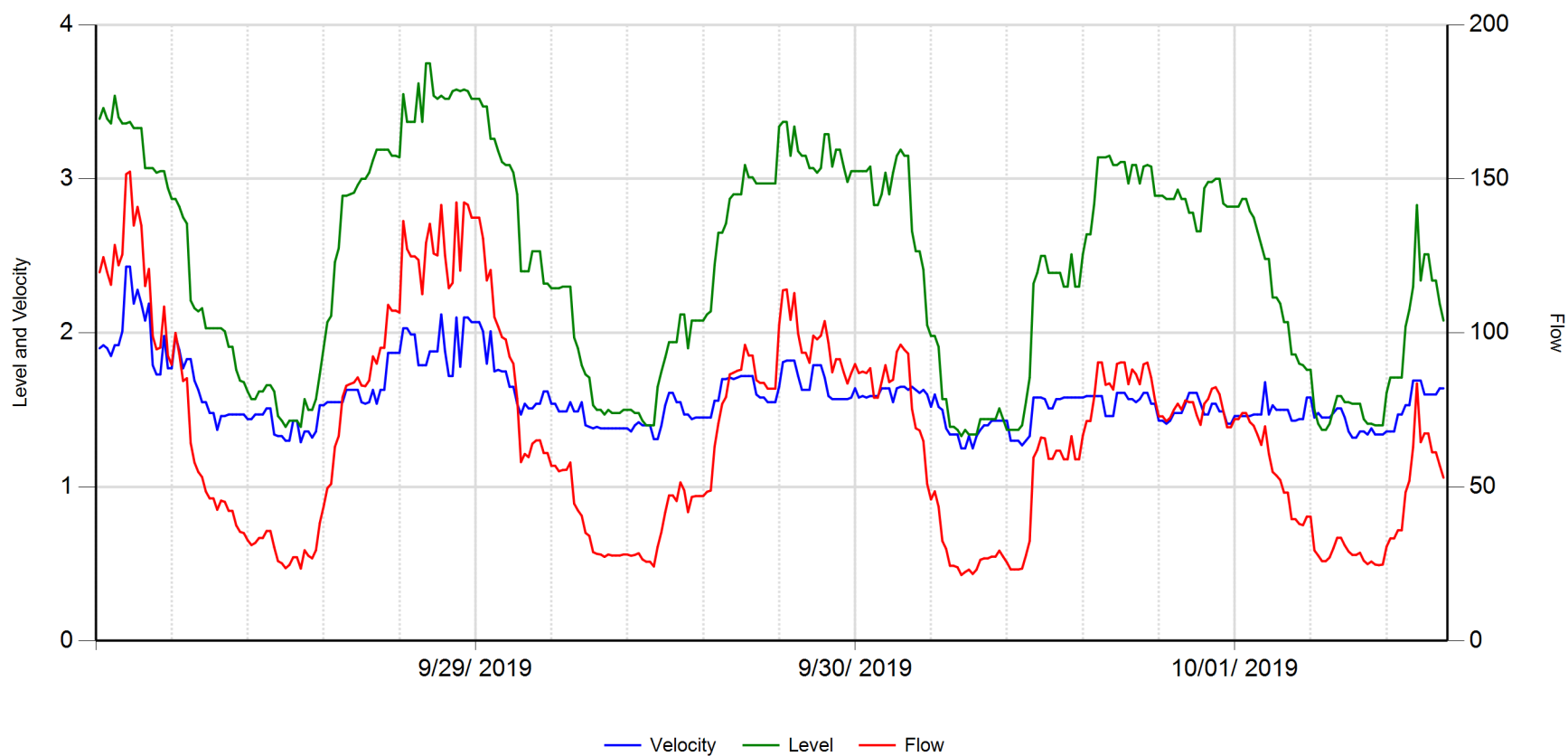


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.615	2.598	73.788	RainFall	Inches
Maximum	2.170	3.840	145.833		
Minimum	1.090	1.360	22.708		



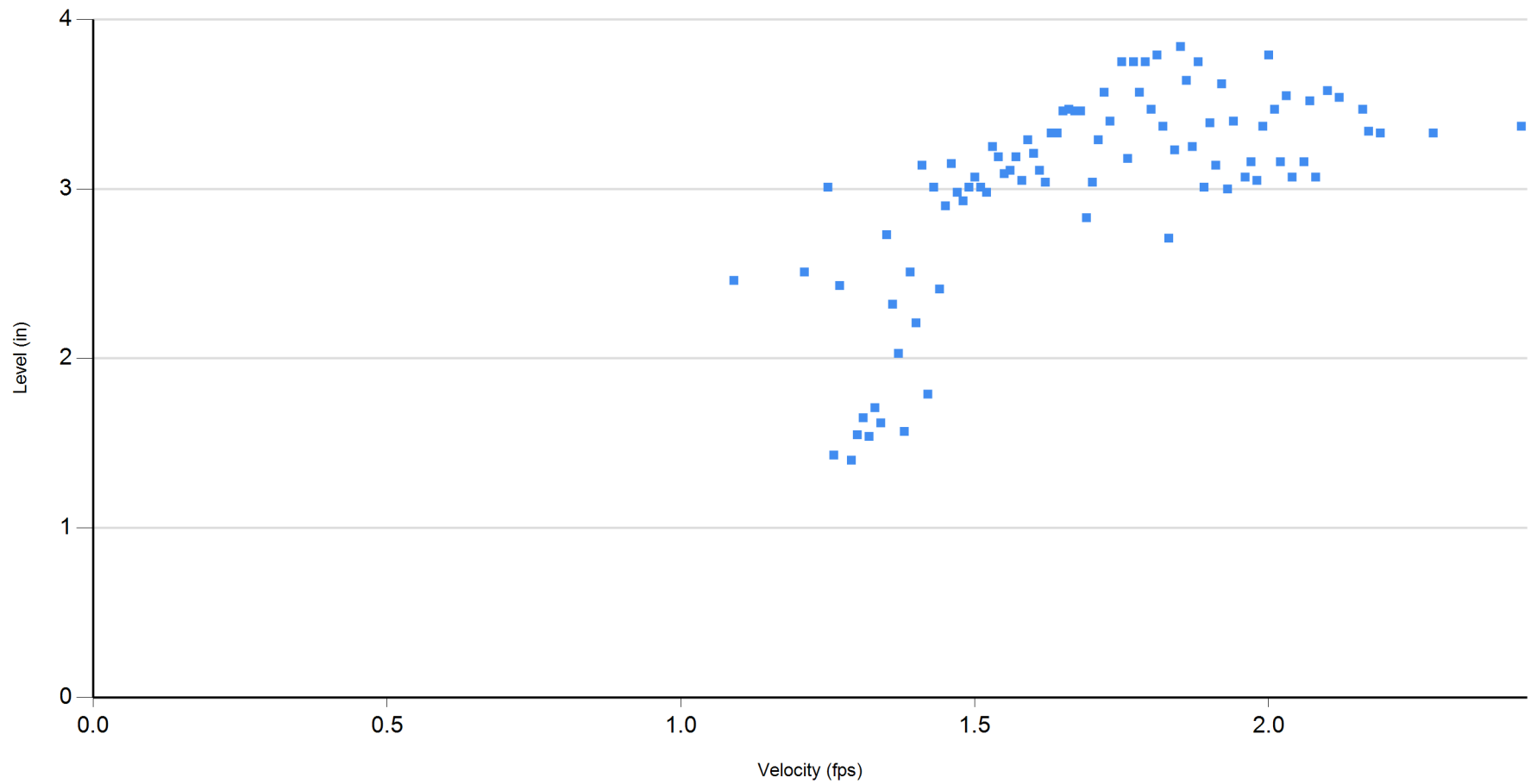
10/14/2019

2019.09 Site 1 MH



	Velocity (fps)	Level (in)	Flow (gpm)			
Average	1.580	2.447	67.636	RainFall	Inches	
Maximum	2.430	3.750	152.361			
Minimum	1.250	1.330	21.389			
					10/14/2019	

2019.09 Site 1 MH



09/24/2019 thru 10/02/2019



10/14/2019 11:08:05 AM



raSmith

MH at ~405 S State College Blvd

Brea, CA 92821

2019.09 Site 2 MH 14-273

MH # 14-273

Access:

MH on sidewalk

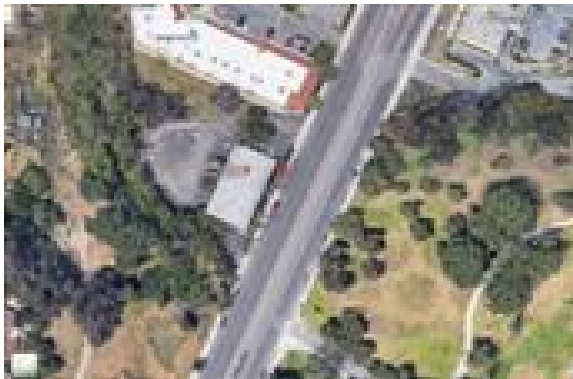
System Type:

Sanitary ☒

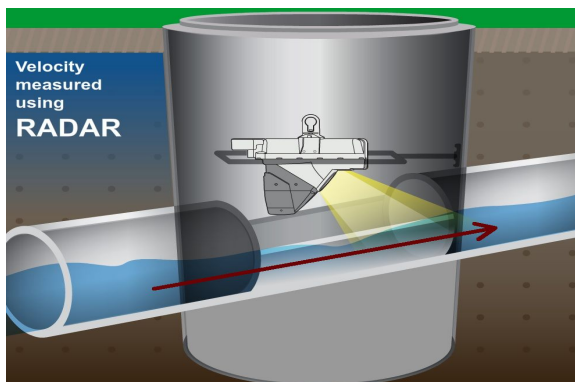
Storm ☐

Install Date: 9/24/2019

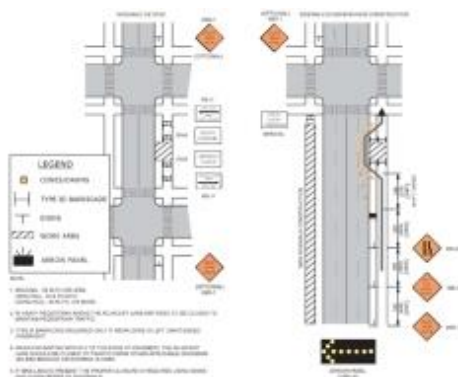
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 95"

MH Coordinates: 33.910330, -117.888919

Moderate open channel hydraulics

Avg Velocity	Avg Measured Level	Multiplier
3.25 fps	1.75"	1.75

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

No laterals; monitored the downstream line as it provided the best hydraulics.

Traffic Safety

No formal TCP required; used cones & signs per WATCH Diagram 2 requirements.

Land Use

Residential	Commercial	Industrial	Trunk
	X		

Manhole Depth 110"

Monitored Pipe Size 8"

Inner Pipe Size (In/Out) 8"/8"

Pipe Shape Round

Pipe Condition Fair

Manhole Material Concrete

Silt 0

Velocity Profile Data *

Velocity Profile Taken 0.4 2-D

Sensor Offset 14.53"

Sensor Dist. to Crown 6.53"

Sensor Direction Downstream

Flow Heading South



Meter Site Document

2019.09 Site 2 MH 14-273

MH at ~405 S State College Blvd

Brea, CA 92821

Site



Manhole Before Install



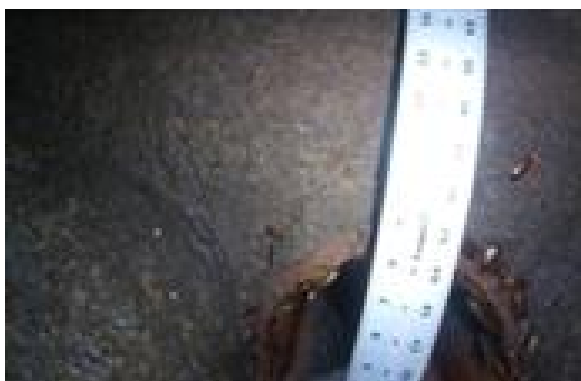
Installation Process



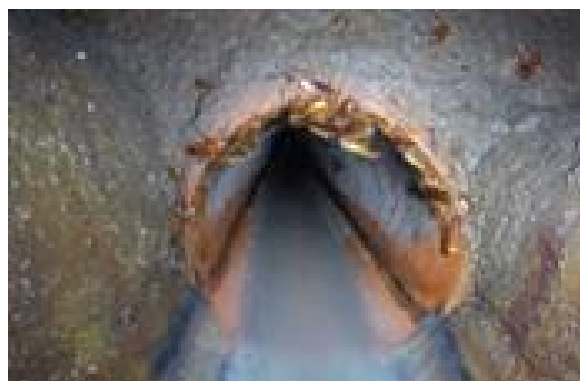
Installed



Downstream Pipe Size



Downstream





Water Science and Software

Report Date: 11/11/2011

Location: S 10

Project: Sonoma Creek Main Project

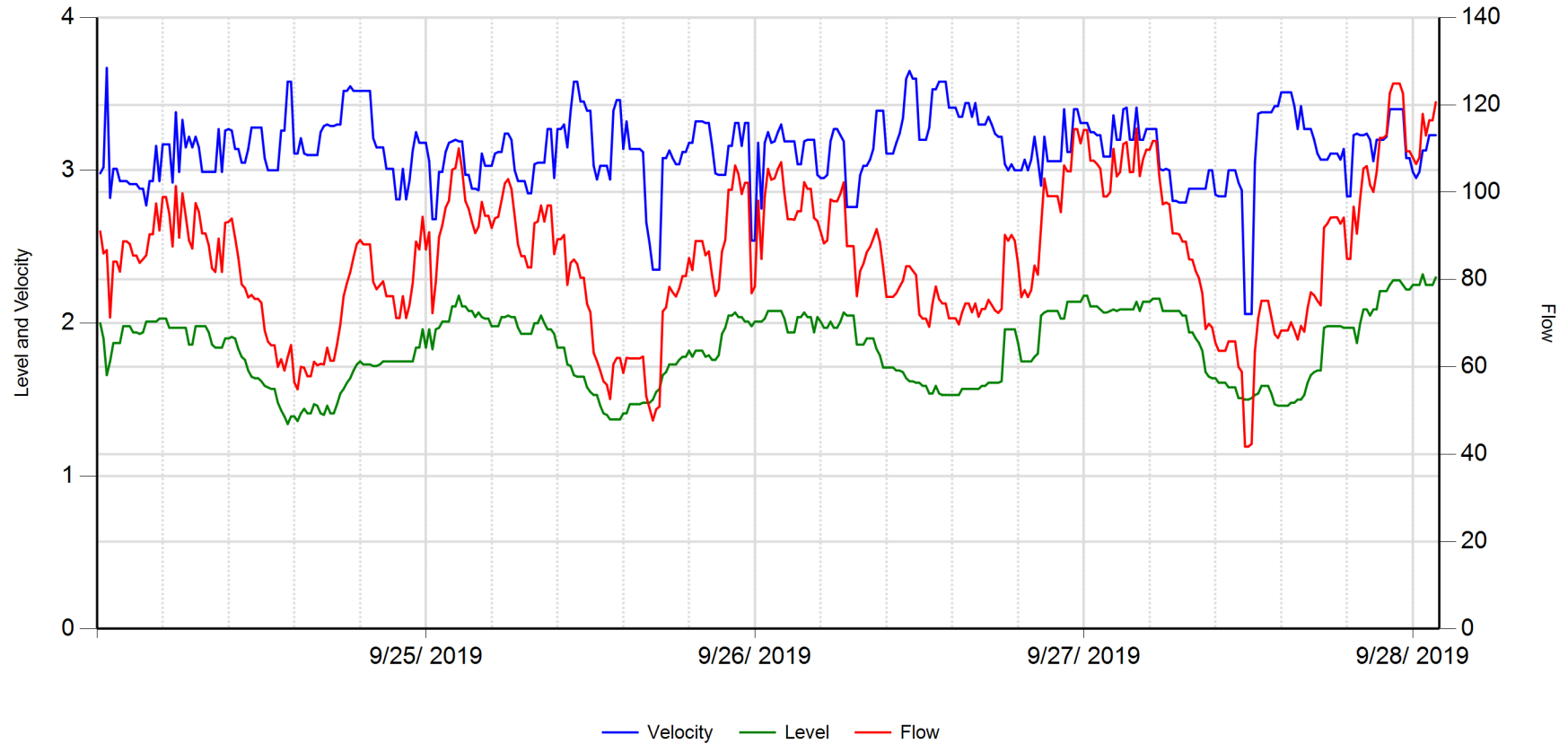
Site: S 10 M 1000

Summary for Sonoma Creek Main Project for 11/11/2011

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
11/11/2011	85.78	124.86	41.74	0.12	0.18	0.06	3.13	3.67	2.06	1.84	2.32	1.34	741,132	
11/10/2011	78.48	106.25	40.28	0.11	0.15	0.06	3.13	3.78	1.96	1.73	2.12	1.40	339,047	
11/09/2011	83.35	124.86	40.28	0.12	0.18	0.06	3.13	3.78	1.96	1.81	2.32	1.34	1,080,179	
Week:	85.78	124.86	41.74	0.12	0.18	0.06	3.13	3.67	2.06	1.84	2.32	1.34	741,132	
11/08/2011	78.48	106.25	40.28	0.11	0.15	0.06	3.13	3.78	1.96	1.73	2.12	1.40	339,047	
11/07/2011	83.35	124.86	40.28	0.12	0.18	0.06	3.13	3.78	1.96	1.81	2.32	1.34	1,080,179	
Week:	78.48	106.25	40.28	0.11	0.15	0.06	3.13	3.78	1.96	1.73	2.12	1.40	339,047	
Totals:	83.35	124.86	40.28	0.12	0.18	0.06	3.13	3.78	1.96	1.81	2.32	1.34	1,080,179	

Page 1 of 1

2019.09 Site 2 MH 14-273

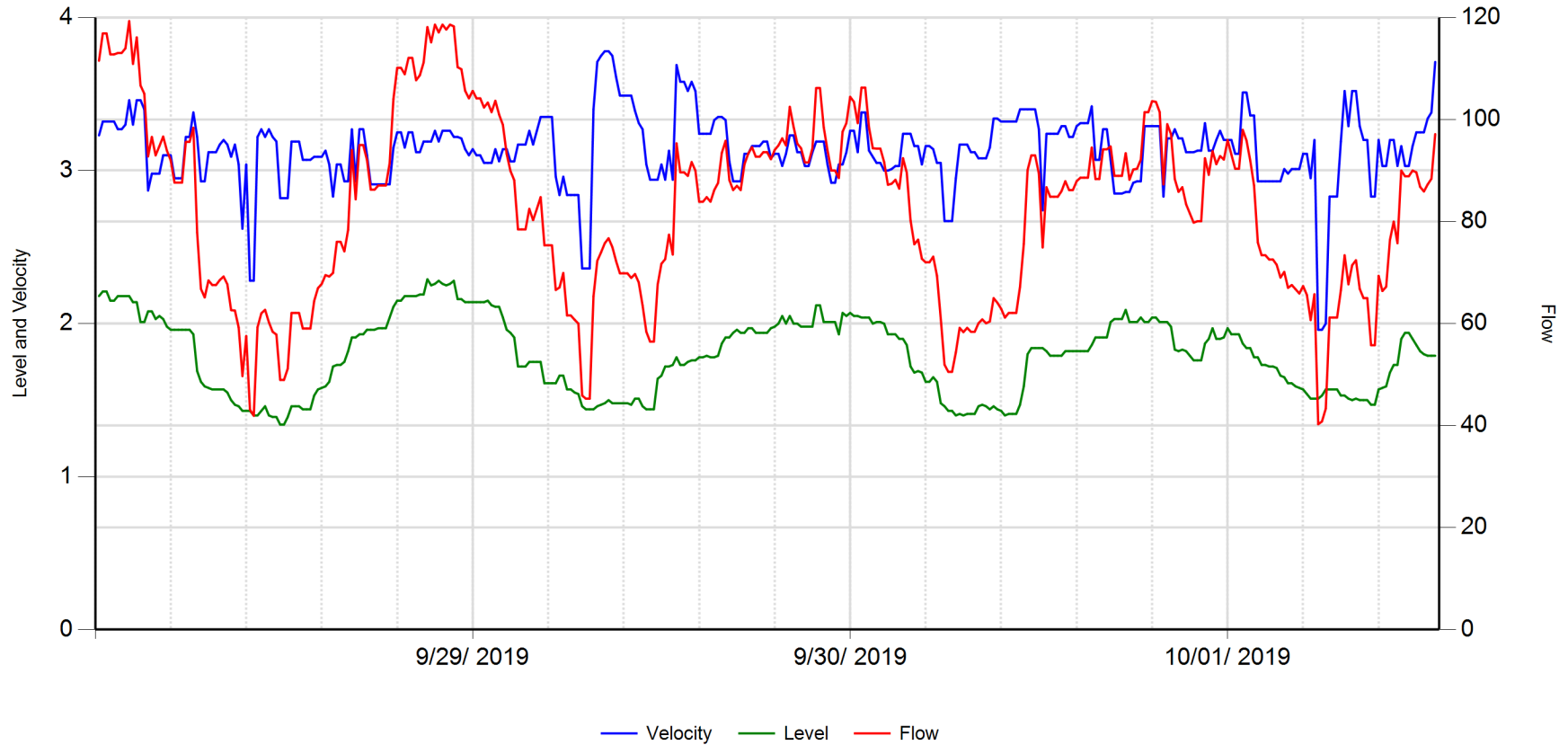


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.139	1.834	85.241	RainFall	Inches
Maximum	3.670	2.320	124.861		
Minimum	2.060	1.340	41.736		



10/14/2019

2019.09 Site 2 MH 14-273

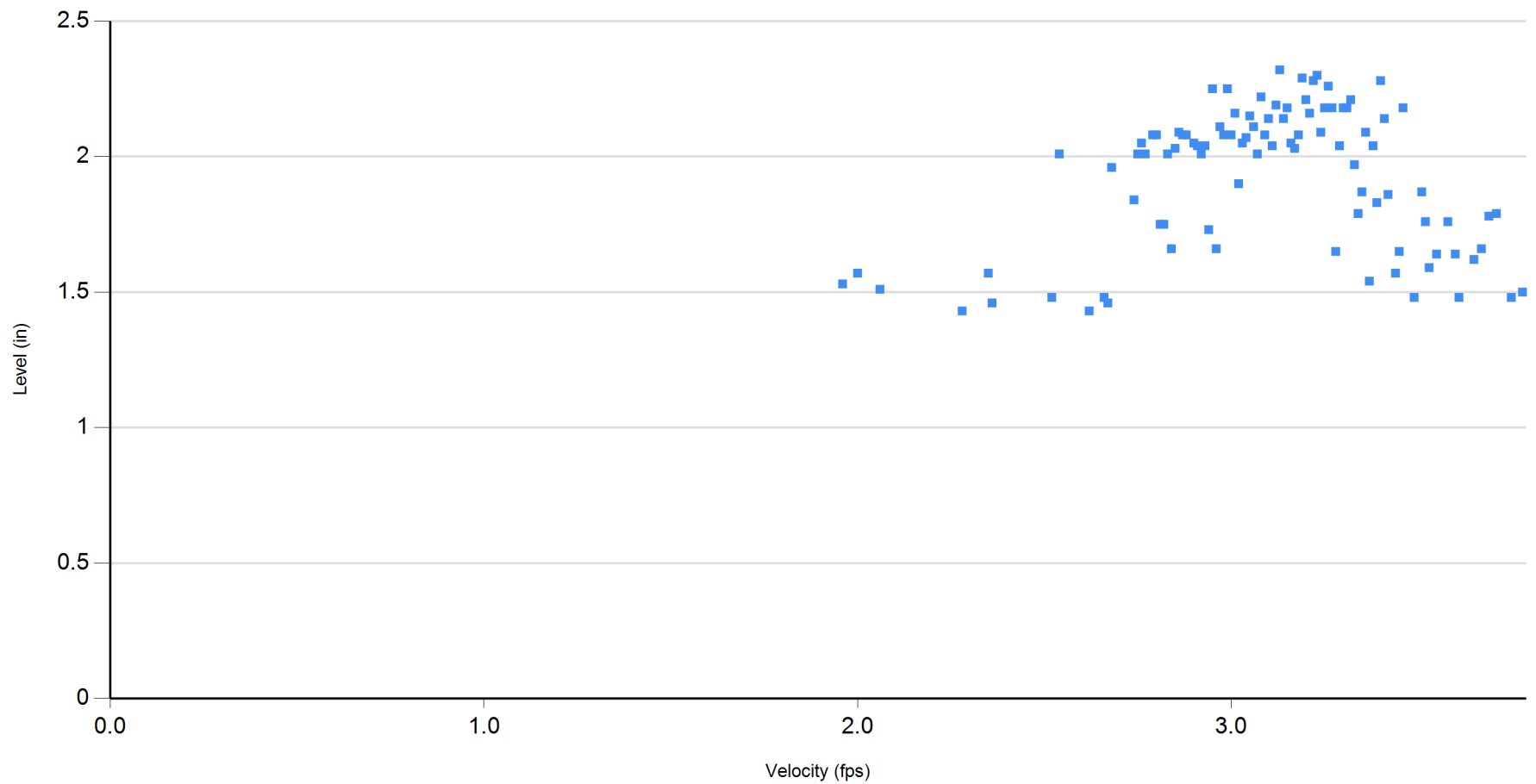


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.135	1.792	82.738	RainFall	Inches
Maximum	3.780	2.290	119.305		
Minimum	1.960	1.340	40.278		



10/14/2019

2019.09 Site 2 MH 14-273



09/24/2019 thru 10/02/2019



10/14/2019 11:08:46 AM



raSmith

MH at ~454 S State College Blvd

Brea, CA 92821

2019.09 Site 3 MH

MH # unknown

Access:

MH in center of painted median

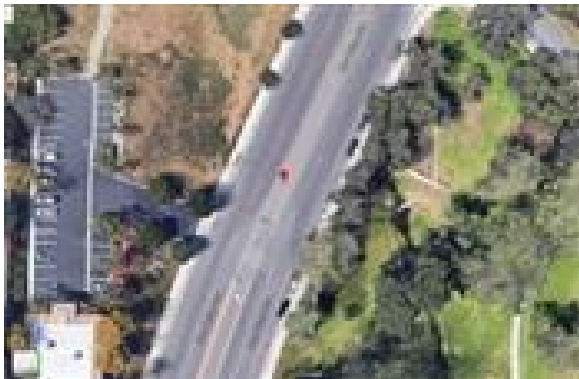
System Type:

Sanitary ☒

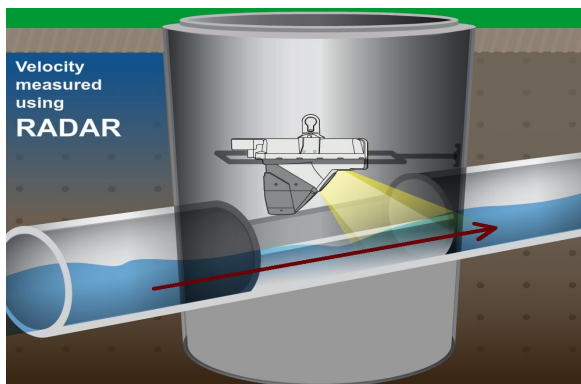
Storm ☐

Install Date: 9/24/2019

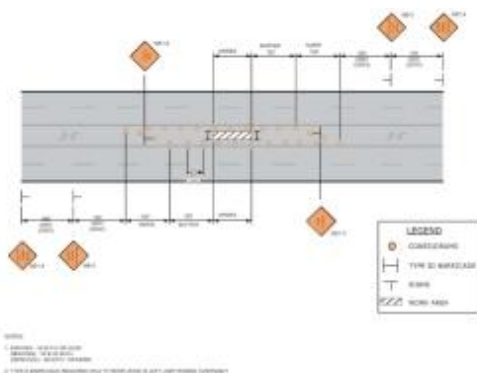
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 281"

MH Coordinates: 33.909322, -117.889302

Poor open channel hydraulics due to inflow from multiple drop inlets

Avg Velocity	Avg Measured Level	Multiplier
3.75 fps	5.25"	1.0

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

Three inlets, one from west & two from north; monitored downstream line to get total flow.

Traffic Safety

No formal TCP required; used cones & signs per WATCH Diagram 20 requirements.

Land Use

Residential	Commercial	Industrial	Trunk
	X		

Manhole Depth 306"

Monitored Pipe Size 18"

Inner Pipe Size (In/Out) 12"/18"

Pipe Shape Round

Pipe Condition Fair

Manhole Material Lined

Silt 0

Velocity Profile Data *

Velocity Profile Taken 0.4 2-D

Sensor Offset 24.73"

Sensor Dist. to Crown 6.73"

Sensor Direction Downstream

Flow Heading East



Meter Site Document

2019.09 Site 3 MH

MH at ~454 S State College Blvd

Brea, CA 92821

Site



Manhole Before Install



Installation Process



Upstream



Downstream Pipe Size



Downstream





Water Science and Software

Report Date: 10/10/2018

Location: S 100

Project: S 100 on S 100 M 100

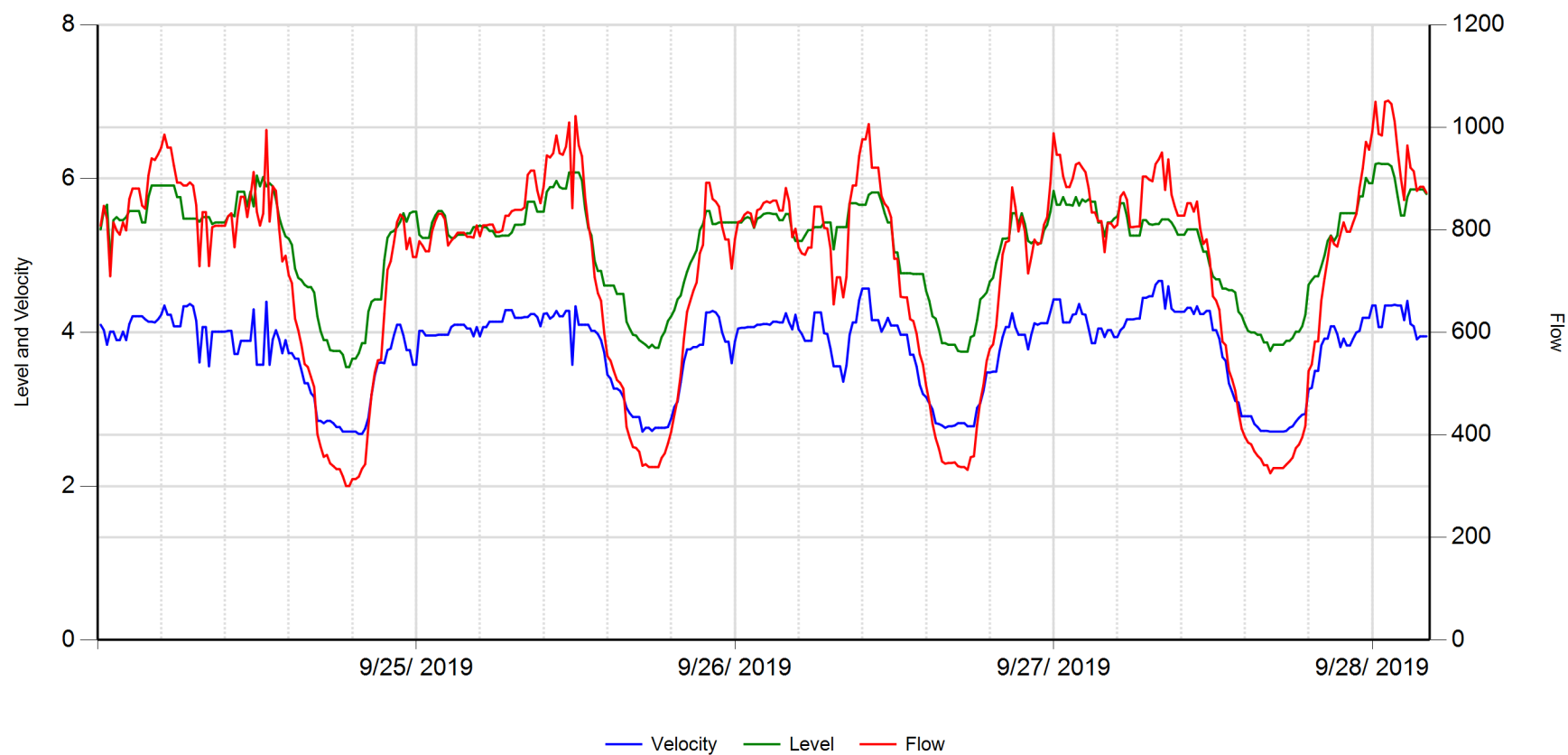
Site: S 100 M 100

Summary for S 100 M 100

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
10/10/2018	736.00	1052.08	284.17	1.06	1.52	0.41	3.79	4.67	2.45	5.19	6.20	3.55	6,359,046	
10/11/2018	651.65	1036.18	292.92	0.94	1.49	0.42	3.45	4.17	2.35	5.04	6.36	3.68	2,815,138	
10/12/2018	707.88	1052.08	284.17	1.02	1.52	0.41	3.68	4.67	2.35	5.14	6.36	3.55	9,174,184	
Week:	736.00	1052.08	284.17	1.06	1.52	0.41	3.79	4.67	2.45	5.19	6.20	3.55	6,359,046	
10/13/2018	651.65	1036.18	292.92	0.94	1.49	0.42	3.45	4.17	2.35	5.04	6.36	3.68	2,815,138	
10/14/2018	707.88	1052.08	284.17	1.02	1.52	0.41	3.68	4.67	2.35	5.14	6.36	3.55	9,174,184	
Week:	651.65	1036.18	292.92	0.94	1.49	0.42	3.45	4.17	2.35	5.04	6.36	3.68	2,815,138	
Totals:	707.88	1052.08	284.17	1.02	1.52	0.41	3.68	4.67	2.35	5.14	6.36	3.55	9,174,184	

Page 1 of 1

2019.09 Site 3 MH

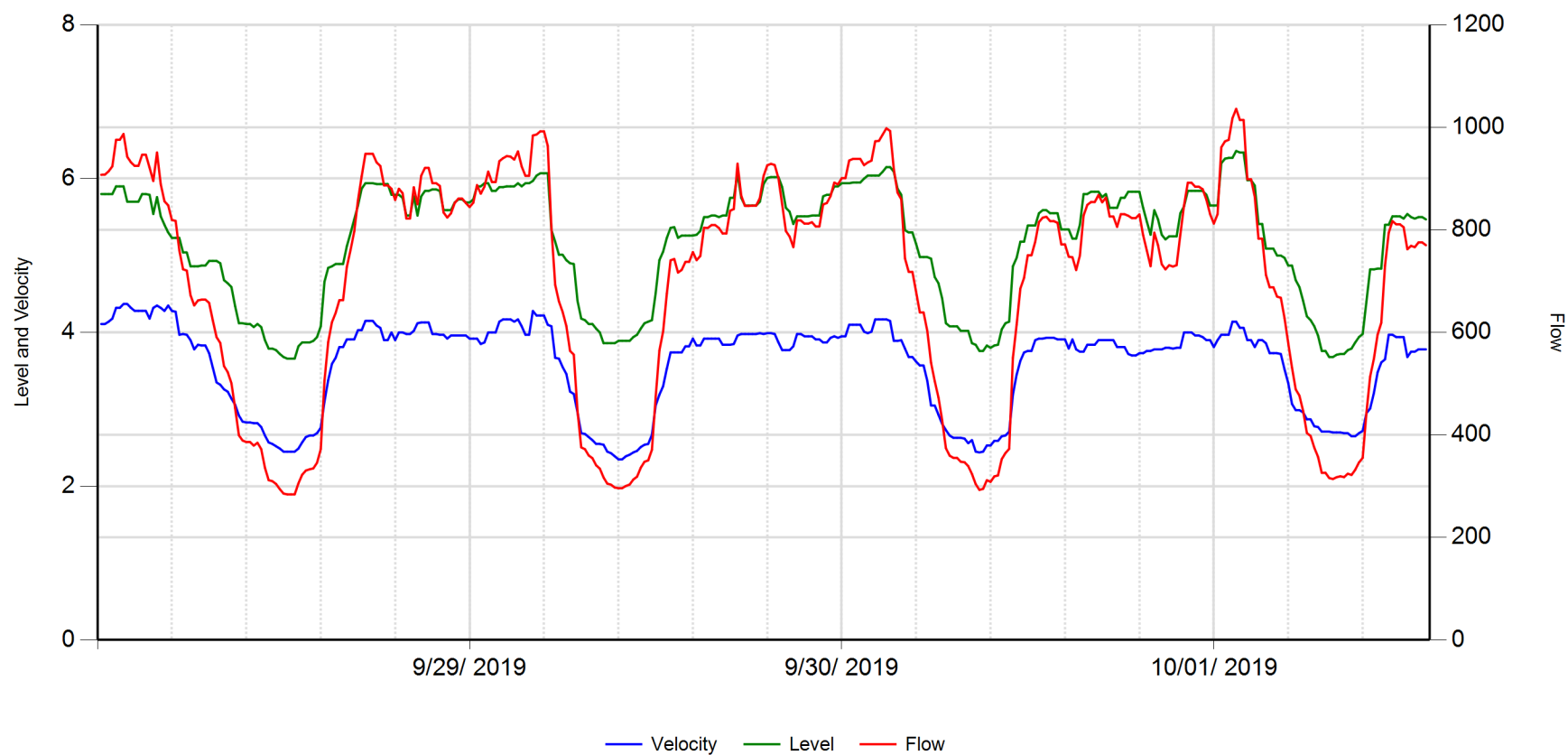


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.793	5.134	725.440	RainFall	Inches
Maximum	4.670	6.200	1052.080		
Minimum	2.680	3.550	300.485		



10/14/2019

2019.09 Site 3 MH

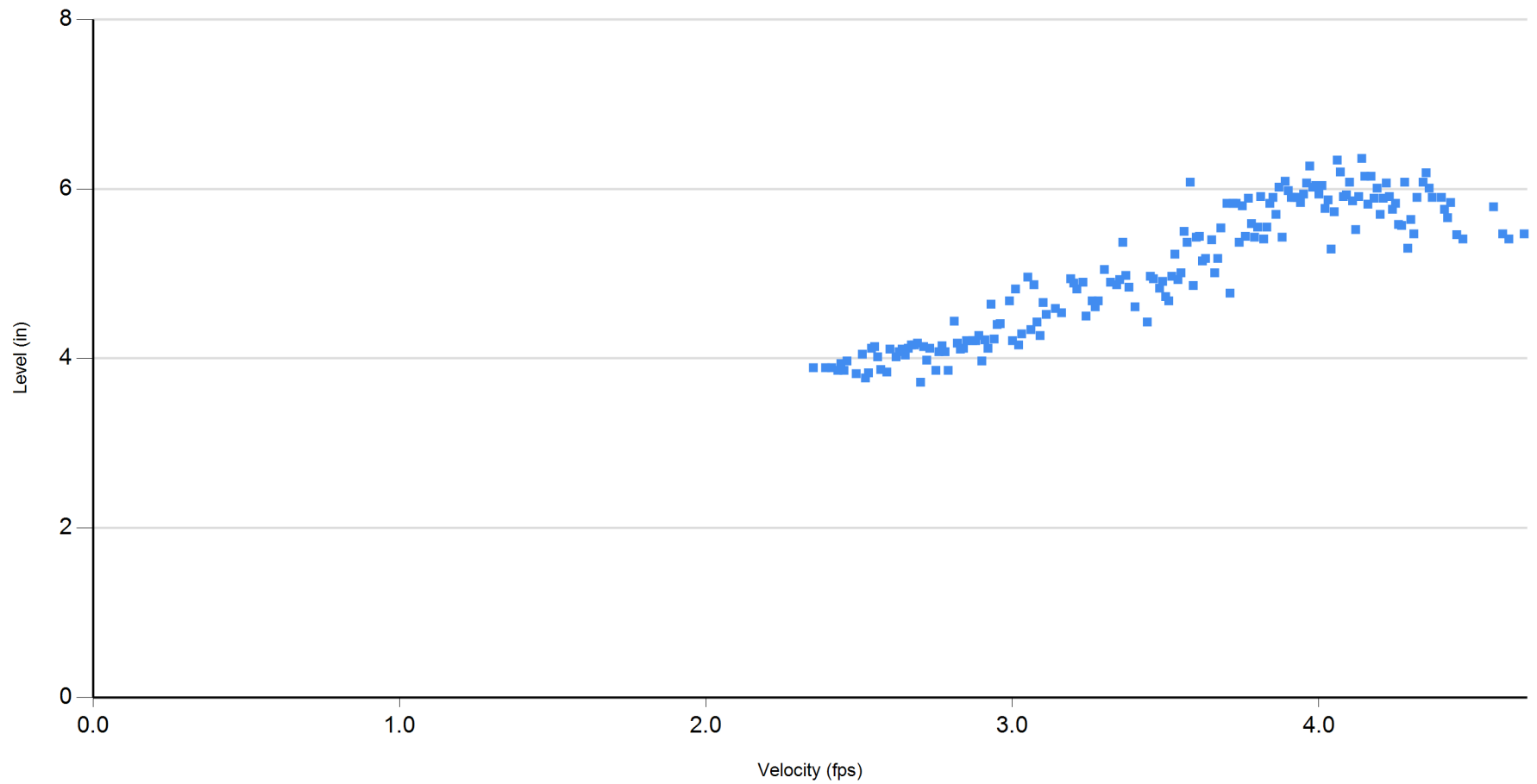


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.584	5.177	700.058	RainFall	Inches
Maximum	4.370	6.360	1036.177		
Minimum	2.350	3.660	284.166		



10/14/2019

2019.09 Site 3 MH



09/24/2019 thru 10/02/2019



10/14/2019 11:09:15 AM



raSmith

MH at ~471 S State College Blvd

Brea, CA 92821

2019.10 Site 4 MH

MH # unknown

Access:

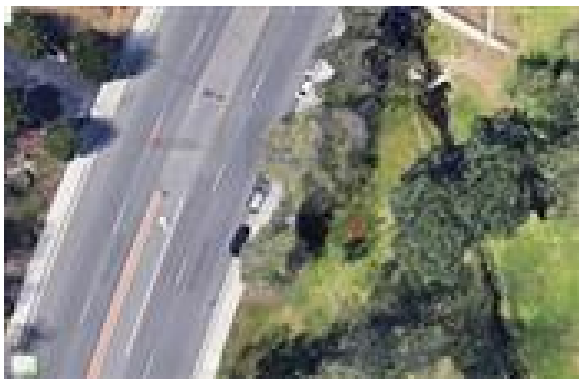
MH in park, E of address

System Type:

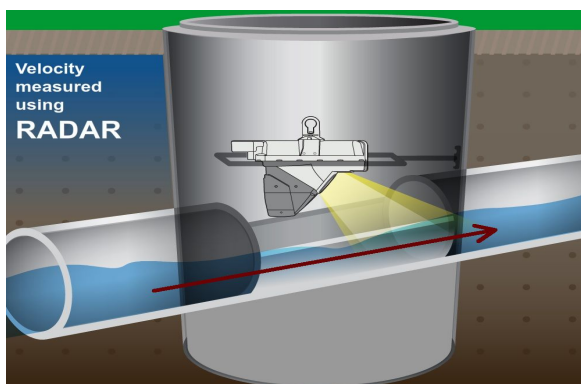
Sanitary ☒Storm ☐

Install Date: 10/02/2018

Map



Technology



MH In Park



Flow Meter

Meter Depth: 85"

MH Coordinates: 33.909049, -117.889105

Moderate open channel hydraulics

Avg Velocity	Avg Measured Level	Multiplier
3.75 fps	4.0"	1.4

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

Three inlets, one from west, one from north & one from south; monitored downstream line to get total flow.

Traffic Safety

MH in open space, no traffic control required.

Land Use

Residential	Commercial	Industrial	Trunk
X	X		X

Manhole Depth 110"

Monitored Pipe Size 18"

Inner Pipe Size (In/Out) 18"/18"

Pipe Shape Round

Pipe Condition Poor

Manhole Material Concrete

Silt 0

Velocity Profile Data *

Velocity Profile Taken 0.4 2-D

Sensor Offset 24.87"

Sensor Dist. to Crown 6.87"

Sensor Direction Downstream

Flow Heading East



Meter Site Document

2019.10 Site 4 MH

MH at ~471 S State College Blvd

Brea, CA 92821

Site



Manhole Before Install



Installation Process



Installed

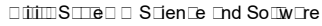


Upstream



Downstream



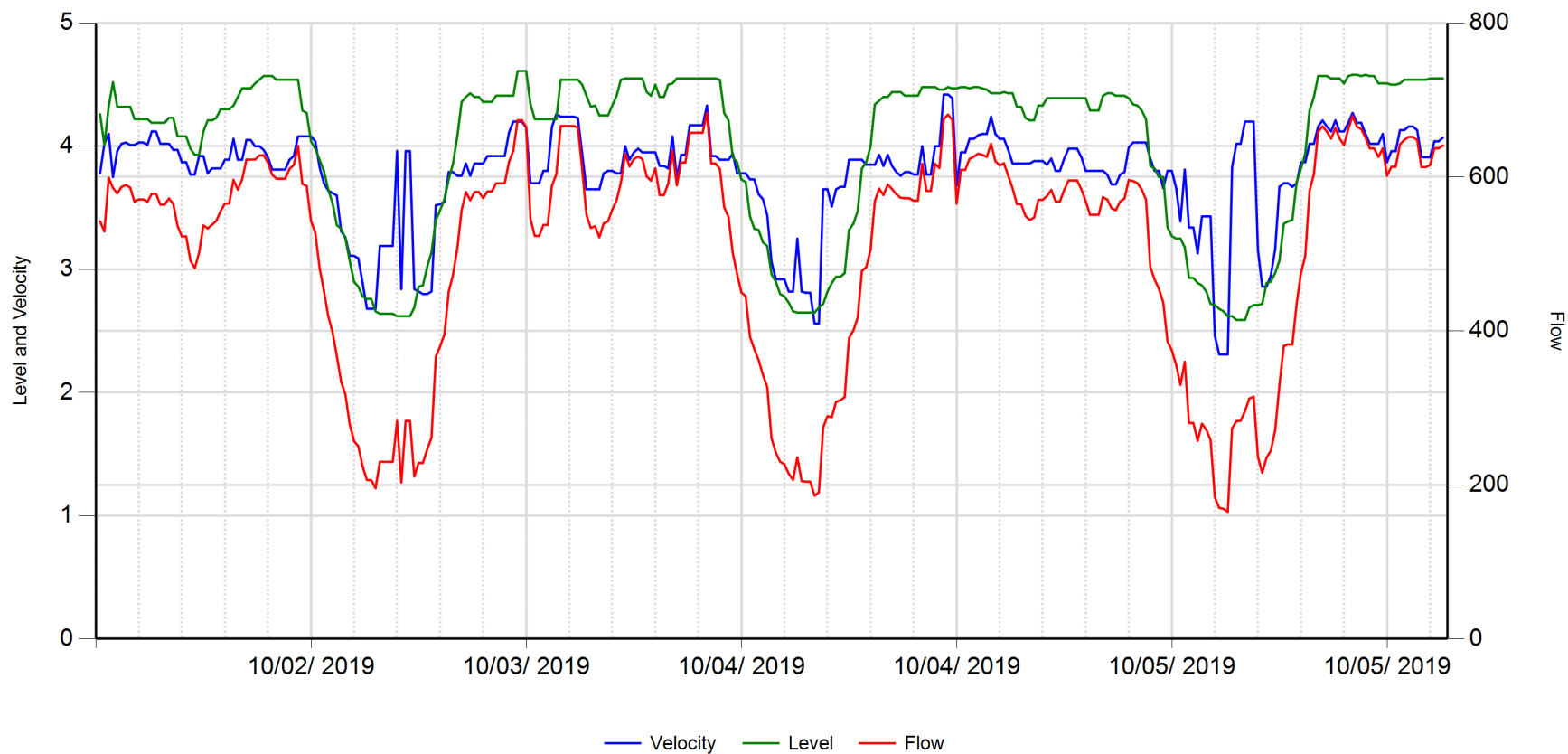


Si e Si e M

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
Week:	515.26	723.40	165.14	0.74	1.04	0.24	3.81	4.42	2.31	4.03	4.94	2.53	3,709,904	
Week:	464.07	721.94	201.60	0.67	1.04	0.29	3.78	4.49	2.62	3.75	4.65	2.59	2,673,055	
Totals:	492.51	723.40	165.14	0.71	1.04	0.24	3.79	4.49	2.31	3.90	4.94	2.53	6,382,959	

K-71

2019.10 Site 4 MH

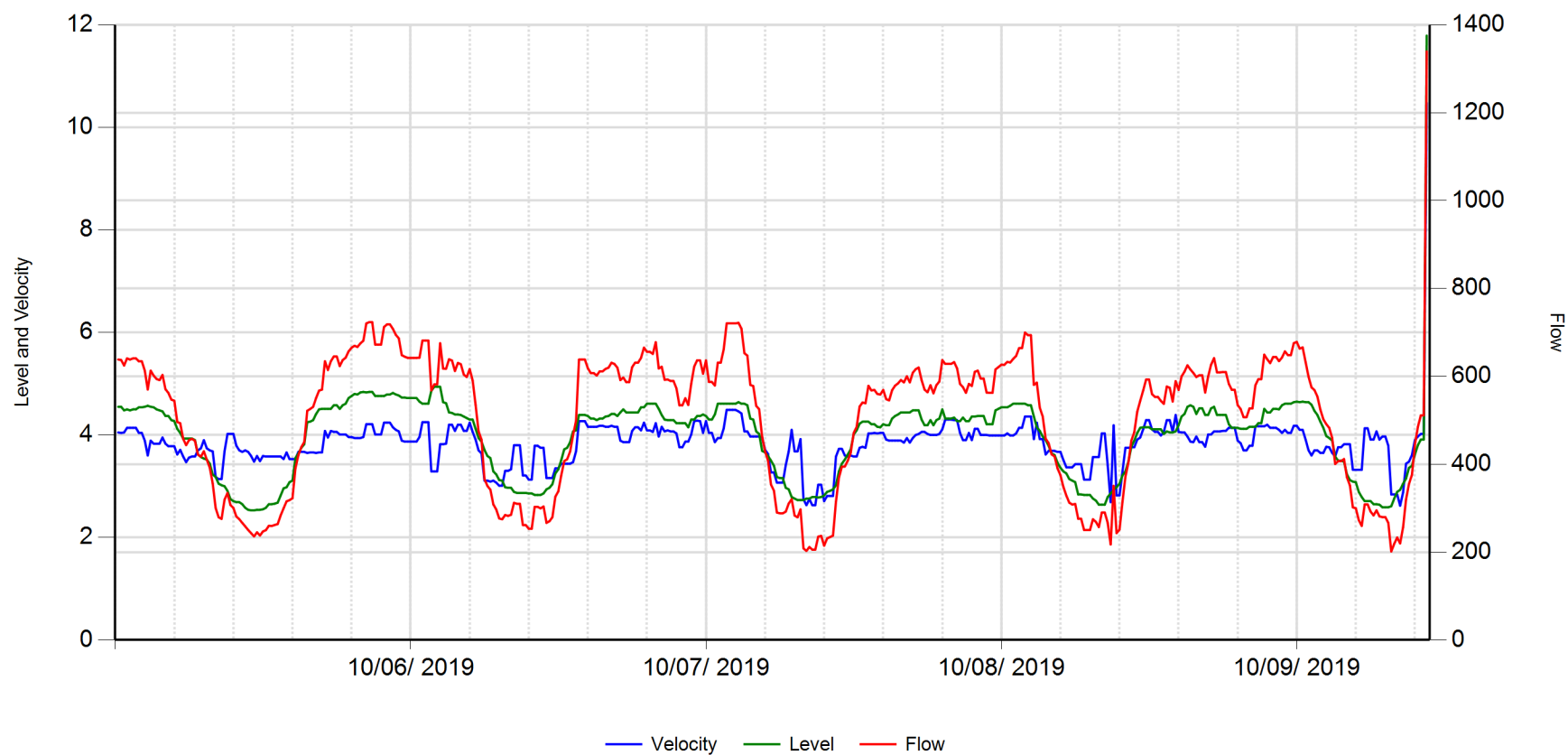


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.776	3.977	504.282	RainFall	Inches
Maximum	4.420	4.610	683.192		
Minimum	2.310	2.590	165.138		



10/14/2019

2019.10 Site 4 MH

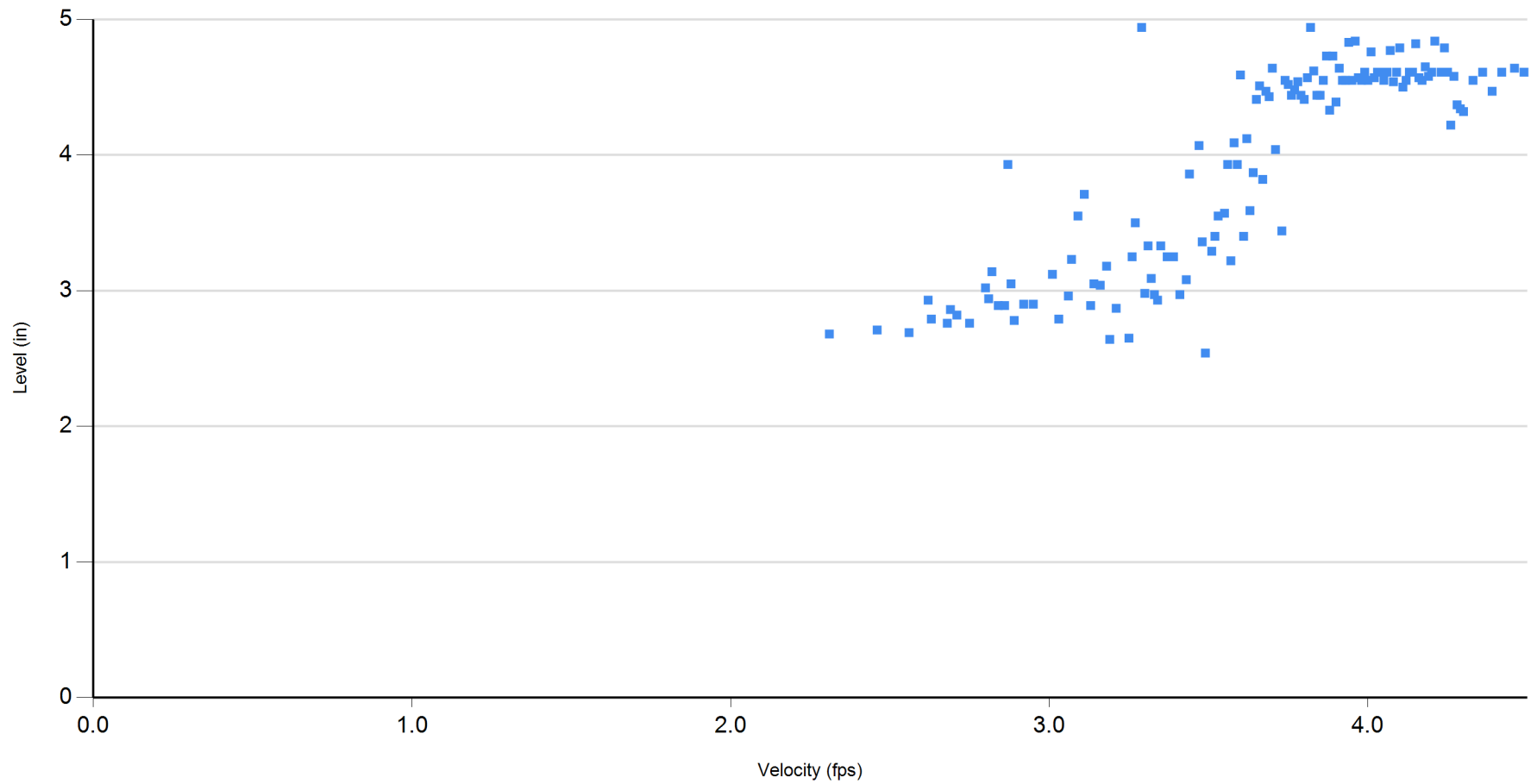


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	3.811	3.928	499.087	RainFall	Inches
Maximum	4.490	4.940	723.401		
Minimum	2.620	2.530	201.597		



10/14/2019

2019.10 Site 4 MH



10/02/2019 thru 10/10/2019



10/14/2019 1:30:40 PM



raSmith

MH at ~120 Brea Mall

Brea, CA 92821

2019.10 Site 1 MH US

MH # unknown

Access:

MH on CL of parking lot access road,
NE of address

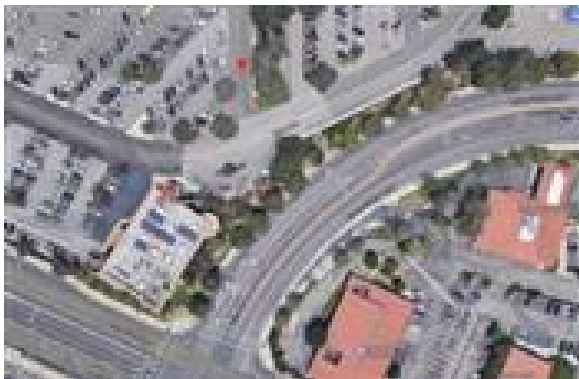
System Type:

Sanitary ☒

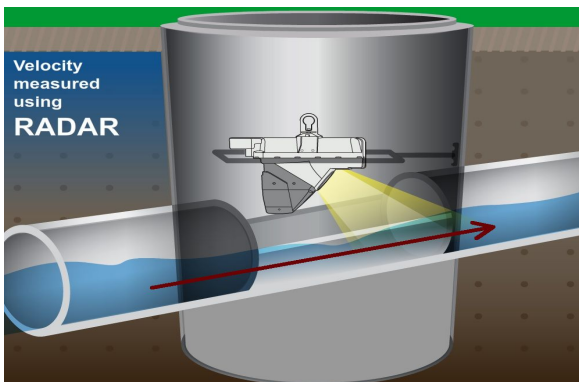
Storm ☐

Install Date: 10/04/2019

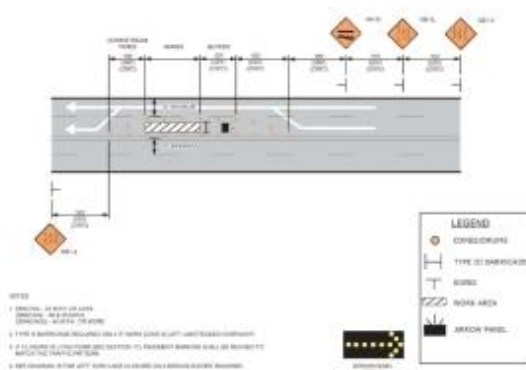
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 153"

MH Coordinates: 33.915117, -117.888619

Moderate open channel hydraulics

Avg Velocity	Avg Measured Level	Multiplier
2.0 fps	2.66"	1.0

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

Two inlets from west & north; monitored
downstream line to get total flow.

Traffic Safety

No formal TCP required; used cones & signs per
WATCH Diagram 15 requirements.

Land Use

Residential	Commercial	Industrial	Trunk
	X		

Manhole Depth	172"
Monitored Pipe Size	8"
Inner Pipe Size (In/Out)	8"/8"
Pipe Shape	Round
Pipe Condition	Fair
Manhole Material	Concrete
Silt	0
Velocity Profile Data	*
Velocity Profile Taken	0.4 2-D
Sensor Offset	18.96"
Sensor Dist. to Crown	10.96"
Sensor Direction	Downstream
Flow Heading	East



Meter Site Document

2019.10 Site 1 MH US

MH at ~120 Brea Mall

Brea, CA 92821

Site



Manhole Before Install



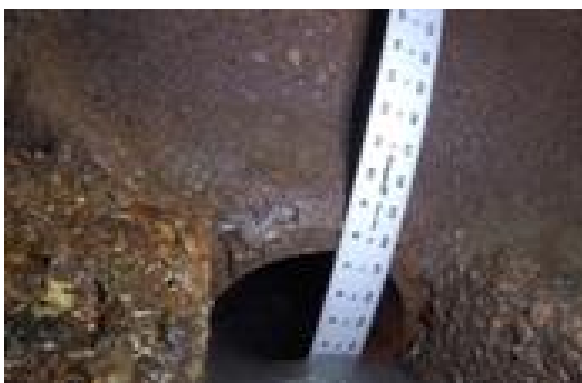
Installation Process



Installed



Downstream Pipe Size



Downstream

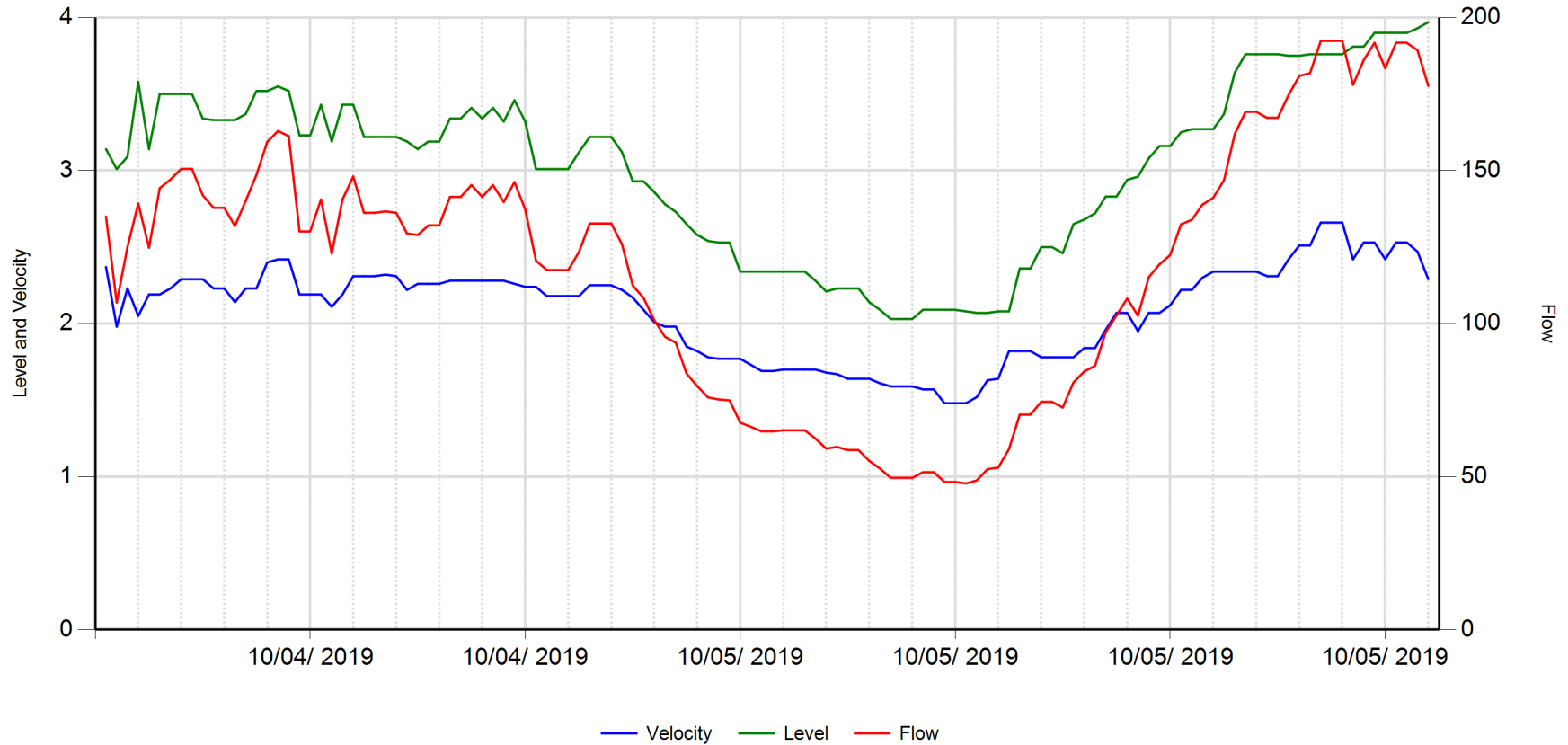




Submit or Save Me Submit or Save

K-77

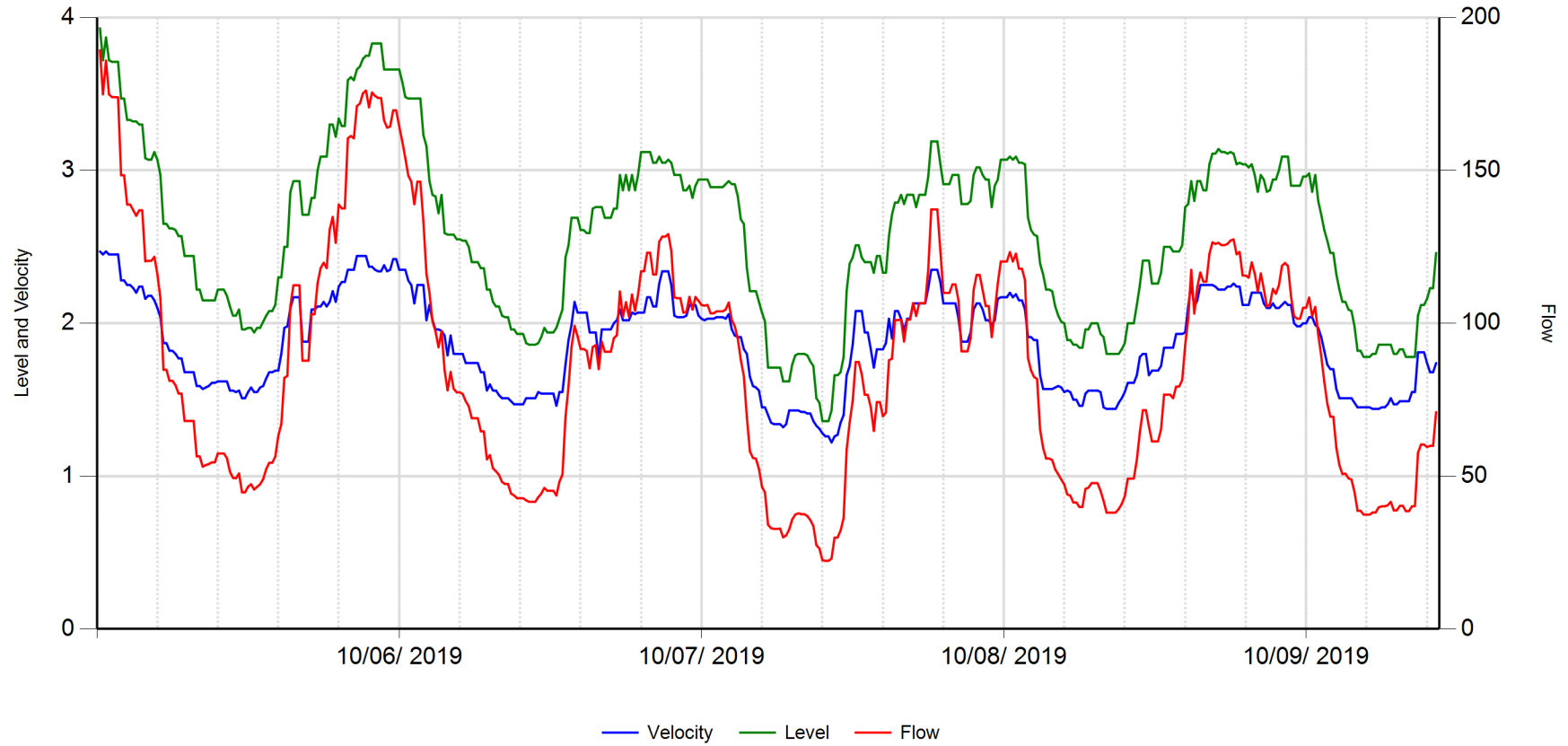
2019.10 Site 1 MH US



	Velocity (fps)	Level (in)	Flow (gpm)	RainFall	Inches	
Average	2.086	3.023	117.515			
Maximum	2.660	3.970	192.361			
Minimum	1.480	2.030	47.778			

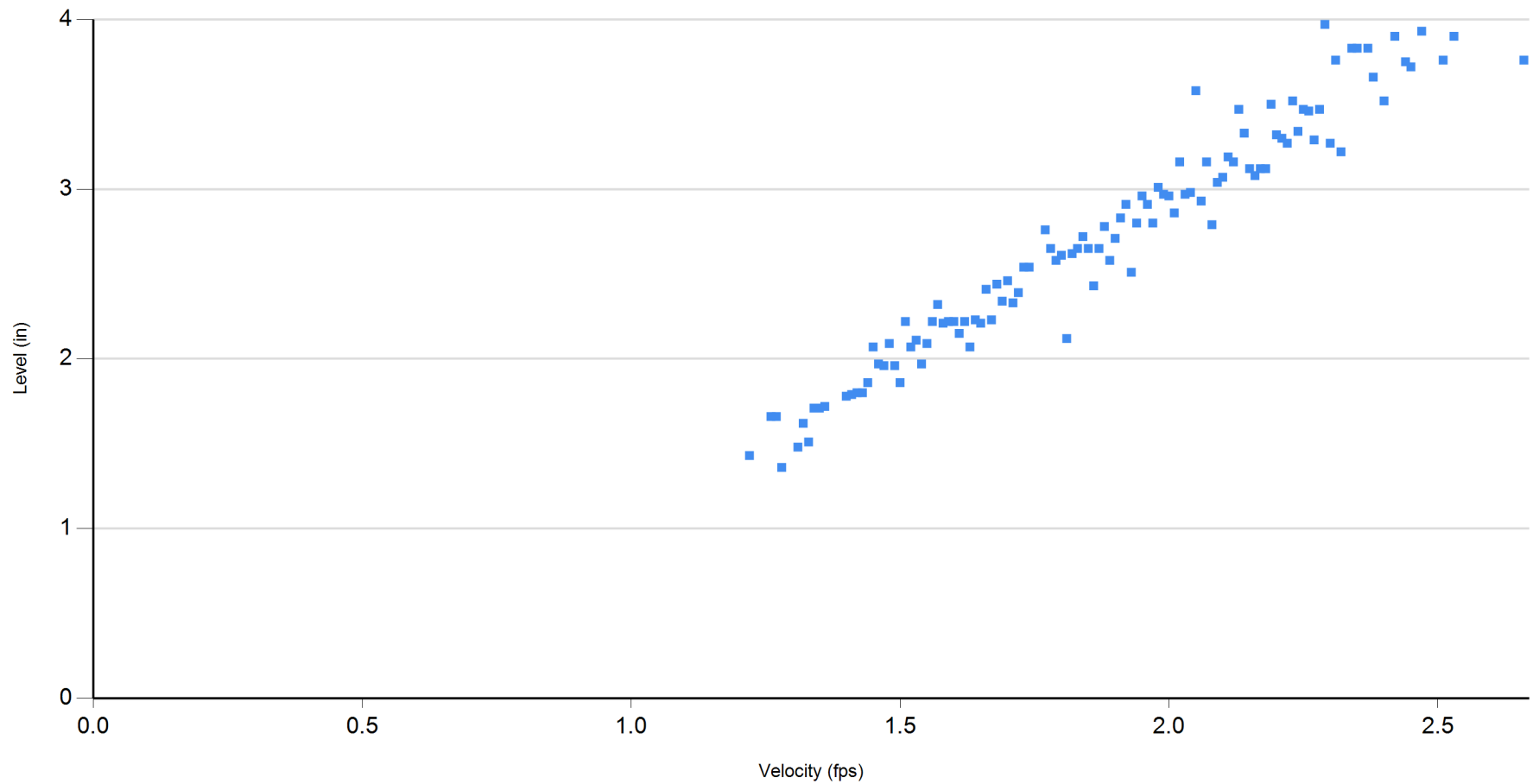
10/14/2019

2019.10 Site 1 MH US



	Velocity (fps)	Level (in)	Flow (gpm)			
Average	1.874	2.583	86.580	RainFall	Inches	
Maximum	2.470	3.930	189.305			
Minimum	1.220	1.360	22.292			
					10/14/2019	

2019.10 Site 1 MH US



10/04/2019 thru 10/10/2019



10/14/2019 1:29:42 PM

Tab 3: Methods & Procedures & Equipment

3.1 Methods and Procedures

Utility Systems Science Software provided assistance with the following non-proprietary flow monitoring solution including the use of the provided Flow Sensor and the associated procedure operation is listed below:

- Obtained permission and proper control of the monitoring site within the area of the Main and on the site of the flow monitoring
- Identified the site for the flow monitoring
- Selected the appropriate equipment Work area and proper control and coordination with the appropriate control and operation of the equipment
- Coordinated with the Main and the equipment and the equipment
- Installed and tested the control and the equipment
- Installed and tested the flow monitoring equipment per the manufacturer's recommendations and the equipment
- Reported the equipment and the equipment and the equipment

3.2 Equipment

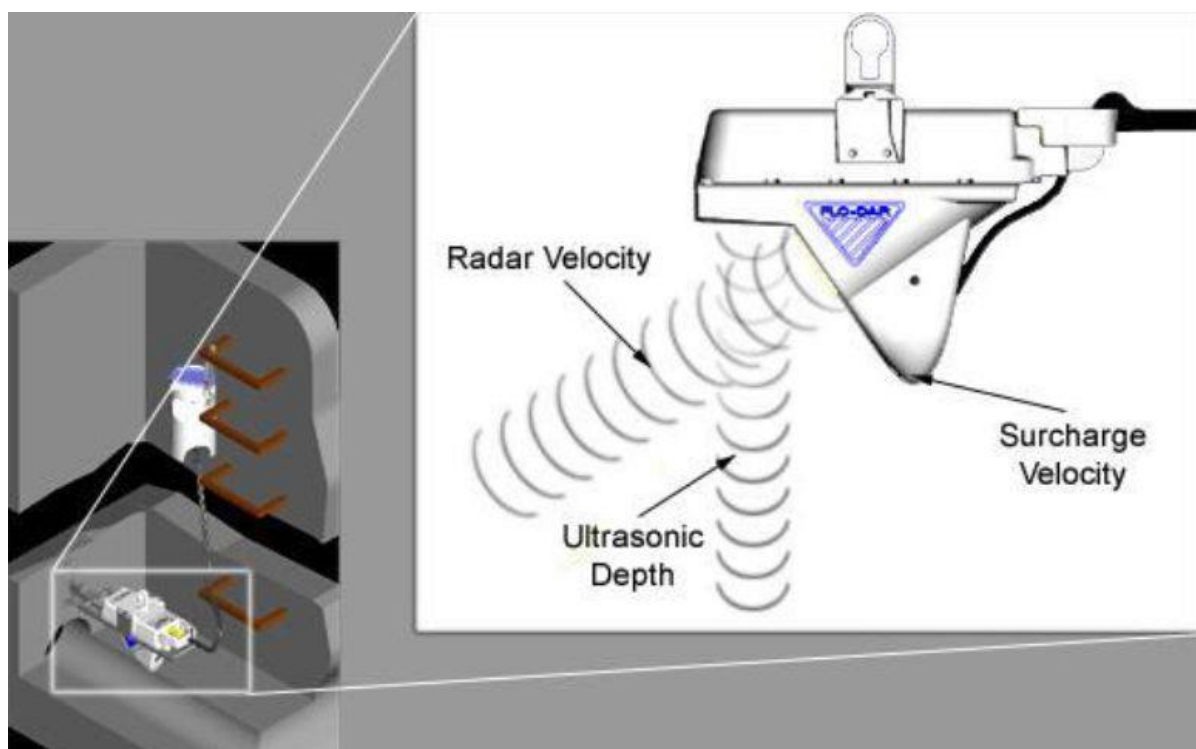


Figure: Equipment installed for proper Sewer Flow Monitoring Site



Figure: Waterproof FloDir Sensor/Recorded Data Logger Flow Meter

3.2.1 SPECIFICATIONS

- **Enclosure**
 - IP68 Waterproof in Polyethylene
- **Dimensions**
 - Overall Width 100mm Depth 100mm in mm
 - Width 100mm Depth 100mm in mm
- **Weight**
 - 100g (approx)
- **Operating Temperature**
 - -20°C to +60°C
- **Storage Temperature**
 - -20°C to +60°C
- **Power Requirements**
 - Supplied 12VDC 100mA 100mA or 100mA

- **Interconnecting Cable**
 - Disconnected from the network center and router or switch
 - Powerline communication in direct Ethernet
 - Standard Ethernet 10/100/1000 Mbps Ethernet
- **Cables – available in two styles:**
 - Connector and end
 - Connector for center with open end to define the defined end with connector to router position with the included end in the end to run the cable through condition
- **Certification**
 - Certified to the Powerline ID or the OD R
 - Indirect and Speed RSS or the OD R

S R R D P M S R M

- zero in in zero error low in
- **Method**
 - Piezore time pressure rounder with in e eedipr
- **Range**
 - in in oerpre re r in e

□□□O□I□□ M□□S□R□M□□□

- **Method**
 - REdir
- **Range**
 - 
- **Frequency Range**
 - 
- **Accuracy**
 - 

D P M S R M

- **Method**
 - [Installation](#)
- **Standard Operating Range from Flo-Dar® Housing to Liquid**
 - [Flo-Dar® Housing to Liquid](#)
- **Optional Extended Level Operating Range from Transducer Face to Liquid**
 - [Transducer Face to Liquid](#)
- **Accuracy**
 - [Accuracy](#)

Flow Measurement

- **Method**
 - Based on continuous measurement
- **Accuracy**
 - Flow readings typically were low in a channel with minor flow conditions and in non-rerouted areas where flow is low

Surcharge Depth supplied by Flo-Dar® sensor

- **Surcharge depth supplied by Flo-Dar® sensor.**

Option 1: Surcharge Depth Sensor

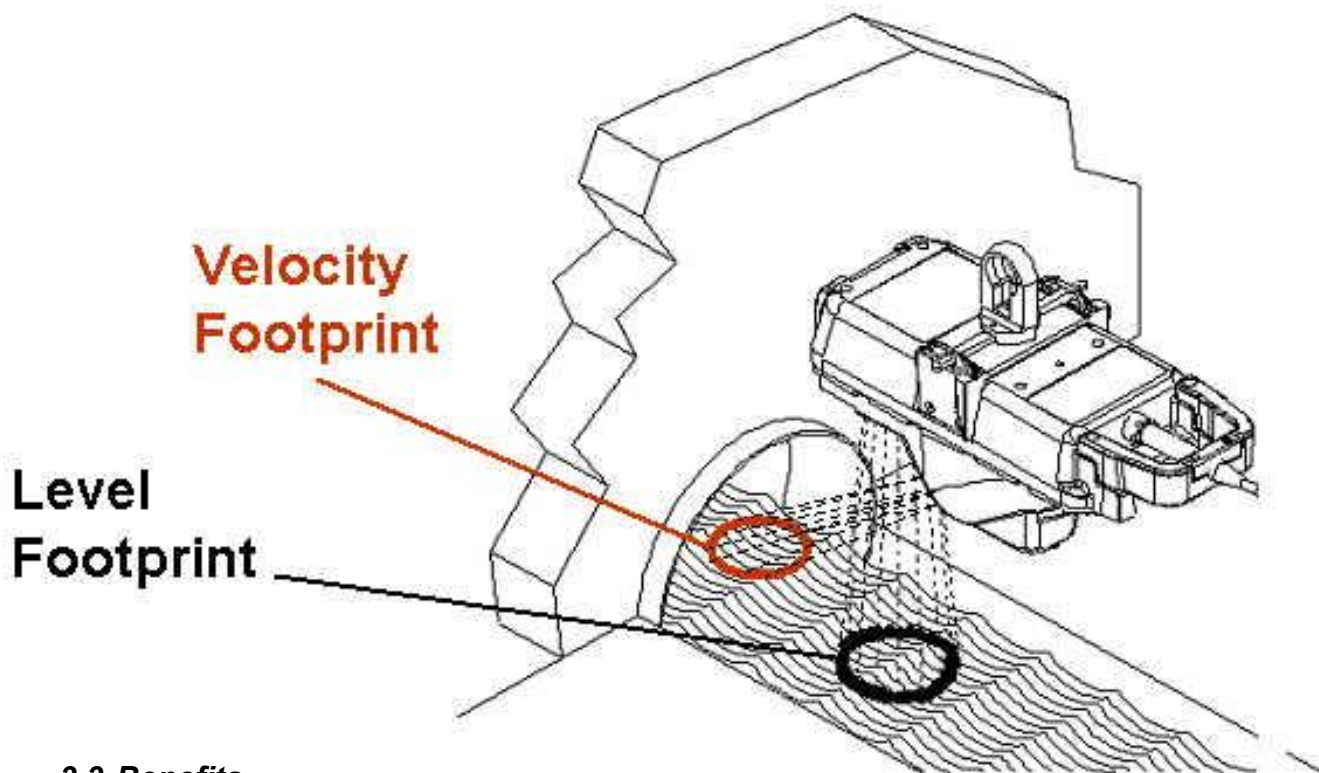
- **Method**
 - Ultrasonic height
- **Range**
 - 0 to 10 feet
- **Accuracy**
 - ±0.1 feet or 0.03 m readings with 1% error
- **Zero Stability**
 - ±0.1 feet

The Flo-Dar Open Channel Flow Meter provide an innovative approach to open channel flow monitoring and is a non-intrusive Doppler radar sensor. The Flo-Dar provides accurate open channel flow monitoring with no moving parts and is protected with a hardened sensor.

3.2.2 Perfect Solution for Difficult Flow Conditions:

- Flow with high Solid Content
- High Temperature Flow
- Turbulent Flow
- Free Man Mode Operation
- High Precision
- Strong Flow





3.3 Benefits

- 3.3.1 Personnel have no contact with the flow during installation
- 3.3.2 Maintenance required on sensor is infrequent
- 3.3.3 Field Replaceable Interference Sensor and Monitor

3.4 How It Works

The device transmits a directional Doppler radar beam that interferes with the fluid and reflects back. The difference between the transmitted and reflected waves is measured. The reflected waves are compared with the transmitted waves to determine the velocity of the fluid. The device provides an accurate measure of the flow rate and is designed to be installed in a pipe without the need for a flow meter or other equipment. The device is mounted on the outside of the pipe.

$$Q = V \times A, \text{ Where } Q = \text{Flow}, V = \text{Average Velocity and } A = \text{Area}$$

3.5 Accurate Flow Measurements

The device provides the user with accurate flow measurements under a wide range of flow and pipe conditions. The device is designed to be installed in a pipe without the need for a flow meter or other equipment. The device is mounted on the outside of the pipe. The device is designed to be installed in a pipe without the need for a flow meter or other equipment. The device is mounted on the outside of the pipe.

Understanding the Flo-DarTM Flow Measuring System

Independent tests verify non-contact flowmeter is highly accurate under both open channel and surcharge conditions

Flo-Dar is the only non-contact open channel velocity/area type flow meter available for measurement of flows in municipal wastewater and storm water sewers. Flo-Dar consists of a radar-based velocity measurement system and an ultrasonic-based pulse echo depth measurement system.

Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides the continuation of accurate flow data where intermittent, surcharged flow conditions are experienced.

Flo-Dar combines the information from the velocity and depth systems along with site specific data (pipe size, pipe shape, velocity profile) and provides the user with highly accurate, reliable flow data under a wide range of flow velocities and depths. Since the radar velocity sensor and the ultrasonic depth sensor cease to provide useful data when submerged, Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides for the continuous measurement of accurate flow data where intermittent, surcharged flow conditions are experienced.

The data system merges the data from these two independent flow systems and provides the user with a single flow signal that accurately represents flow over a range from a dry pipe to extreme surcharge conditions. Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Measurement of Flow Under Free Flow, Non-submerged Conditions

Open Channel Velocity

Open channel flow is any flow in a channel that has a free surface. Flo-Dar measures open channel flow as depicted in Figure 1. The radar velocity sensor measures flow in a manner similar to how radar guns measure the velocity of a baseball or an automobile.

Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

Factors that influence the accuracy and stability of the measured surface velocity signal:

1. *Transmitted Frequency*
2. *Speed of Microwaves in Air*
3. *Angle of Microwave Beam*
4. *Calculation of Mean Velocity*

A radar “horn” contained inside of the watertight housing transmits a microwave beam through the housing at a defined angle to the flow surface. Disturbances on the surface reflect some of the microwaves back to the horn. The frequency of these returning microwave signals have been shifted (the Doppler effect) by an amount directly proportional to the speed of the moving surface. This frequency shift is detected and measured by the Flo-Dar flow meter and the data is stored as a measure of the surface velocity.

Since the accurate measurement of open channel flow requires the accurate determination of the average velocity of the flow stream, the measured surface velocity must be dynamically modified to obtain an accurate average velocity for use in the Continuity Equation, $Q = V_{av} \times A$. Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

If one analyzes each of the four factors that influence the accuracy and stability of the measured surface velocity signal, it becomes obvious that a Doppler Radar based velocity sensor is very accurate and stable:

1. Transmitted Frequency - The transmitted frequency of 24.175 GHz is controlled to an accuracy of $\pm 0.065\%$
2. Speed of Microwaves in Air - Essentially constant at the speed of light
3. Angle of Microwave Beam - The sensor is placed in a rigid mount that is positioned parallel to the water surface (i.e. nearly level). The sensor can be removed from the mount and reinstalled while easily maintaining its original mounting location.
4. Calculation of Average Velocity—The relationship between the sensed (surface) velocity and the average velocity varies with pipe size and water depth.

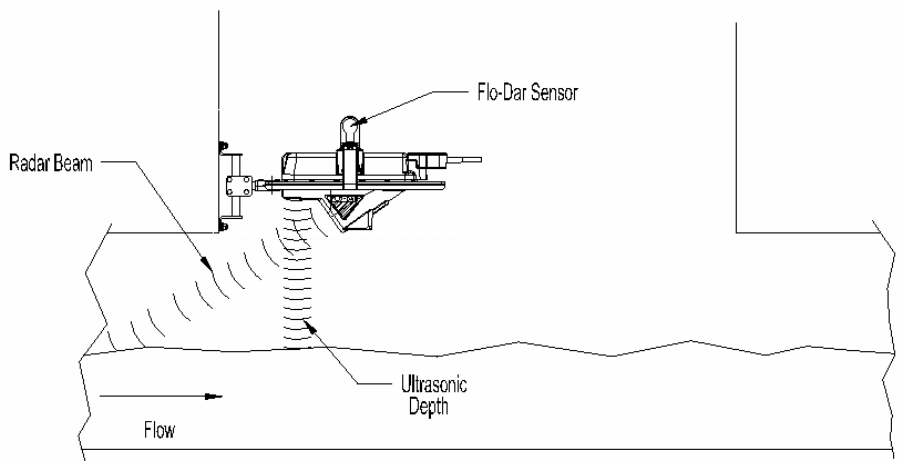


Figure 1

By applying algorithms developed through basic hydraulic principles and from actual flow data taken at Alden Labs and at various customer sites, the surface velocity is transformed into an accurate representation of the mean velocity.

Since the location of the sensing region on the flow surface is known, the repeatability of the surface velocity measurement is excellent and its relationship to the mean velocity is very predictable.

Since the location of the sensing region on the flow surface is known, the repeatability of the surface velocity measurement is excellent and its relationship to the mean velocity is predictable.

Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different depth/Diameter ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface - essentially creating a "finger-print" of the velocity contours that exist beneath the surface.

As one might expect, the velocities near the wall are less than the mean velocity and those near the surface are greater than the mean velocity. Since a) the radar sensor measures surface velocity at a known location on the flow surface, and b) these various surface velocities have known relationships to the mean velocity, then the mean velocity can be reliably and accurately calculated.

The accuracy of the calculated average velocity, after correction, is typically between 2% to 5%.

Note that the velocities present on the surface are typically within 10% of the average velocity. The accuracy of the calculated mean velocity, after correction, is typically between 2% to 5%. (See Note 1.)

Ultrasonic Pulse Echo Depth Measurement

Ultrasonic pulse echo depth sensors operate by energizing a piezoelectric transducer with an electronic pulse. This pulse creates an ultrasonic pulse of energy that travels to the flow surface where a portion of the energy returns to the transducer.

The transit time to the flow surface and back is recorded and the distance calculated by knowing the speed of sound at the site which has been corrected by an embedded temperature sensor. The accuracy of the depth measurement is 1%, +/- 0.1 inch .

Measurement of Flow Under Submerged Conditions

Electromagnetic (EM) Surge Velocity Sensor

As stated previously, the radar based velocity sensor measures the surface velocity of the flowing stream by detecting the average speed of the surface irregularities. When the radar sensor becomes totally submerged, it becomes "blind" and is no longer capable of measuring the fluid velocity.

Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different depth/Diameter ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface—essentially creating a “finger-print” of the velocity contours that exist beneath the surface.

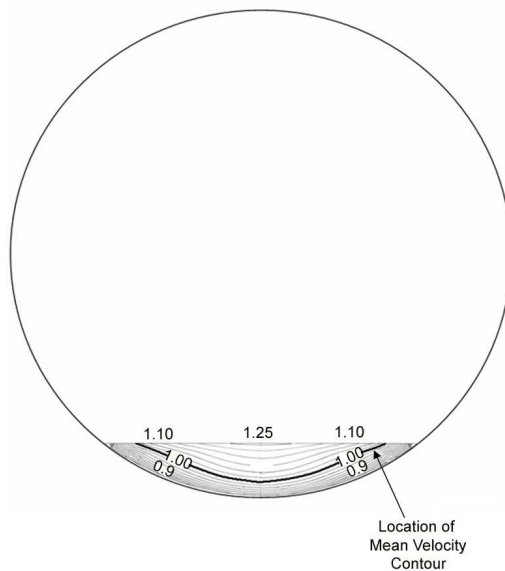


Figure 2a:
 $d/D = 0.10$

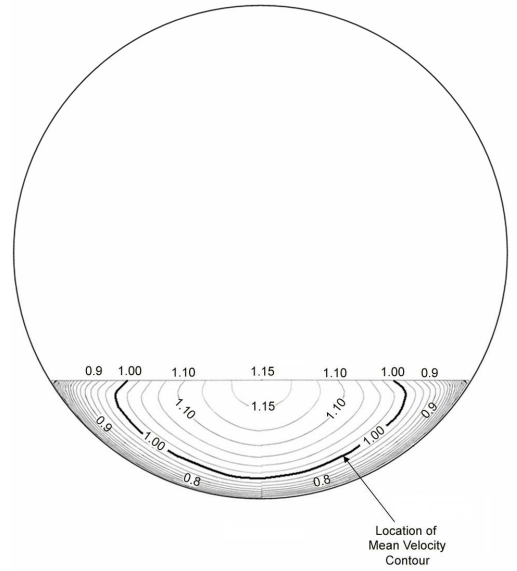


Figure 2b:
 $d/D = 0.25$

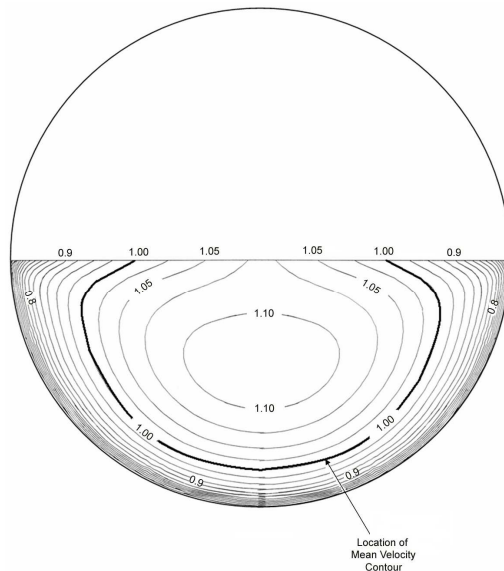


Figure 2c:
 $d/D = 0.50$

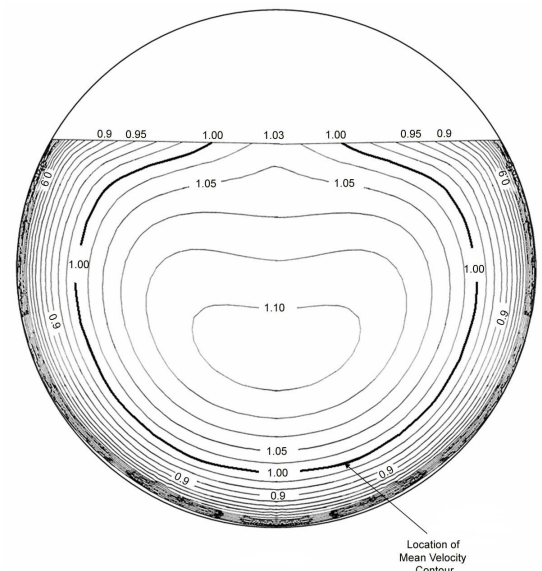


Figure 2d:
 $d/D = 0.75$

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor. Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within four inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor.

Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within 4 inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

The optional surcharge velocity sensor is based on the Faraday Principle of Electromagnetic Induction. This is the same well-proven principle that “full bore” or “spool-piece” magmeters utilize, the most widely used method of measuring wastewater flow in full pipes.

In the Marsh-McBirney design, an electromagnet embedded within the streamlined sensor generates a magnetic field in the flowing stream. The flow of the water passing through this magnetic field generates voltages in the water that are directly proportional to the speed of the water passing the sensor. Marsh-McBirney uses an in-house 120 foot long towing basin for calibration of electromagnetic sensors. Tow carriage accuracy is better than $\pm 0.5\%$.

Surcharge Depth Sensor

Once submerged conditions exist, the ultrasonic depth sensor ceases to provide useful depth information. To measure depth of the flow during surcharge conditions, a pressure transducer embedded in the Flo-Dar sensor is used in the system.

The location of the surcharge velocity sensor relative to the crown of the pipe is shown in Figure 3. This location provides sensing of the velocity stream just below the crown of the pipe where the flow exits the upstream piping. Empirical data, verified by independent tests at Alden Labs in Holden, Massachusetts indicate that the velocity measured at this location, when multiplied by 0.9, is typically equal to the average velocity.

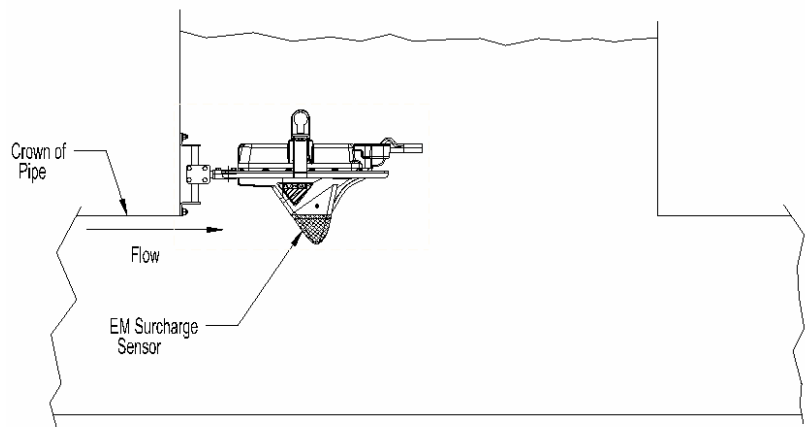


Figure 3

Laboratory Tests

In September 2002 Marsh-McBirney contracted Alden Research Labs of Holden, Massachusetts to perform flow accuracy tests on the Flo-Dar sensor with an electromagnetic surcharge sensor. The Flo-Dar was subjected to a flow range of 400 gpm to over 9000 gpm in a pipe size of 23.5 inches. The pipe had a slope of approximately zero. The test results are shown in Figure 4, Figure 5, Figure 6 and Figure 7.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

Tests were also run to depict how Flo-Dar performs under transition conditions where the flow goes from an open channel condition to a surcharge (submerged) condition.

Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard. Tests were run under both free flow conditions as well as where the pipe outlet was partially blocked so as to create an entirely different velocity/depth relationship.

Additional flow accuracy tests were run on a 36" pipe at Alden on July 17, 2003. All of the data points were shown to be within 3.5% of the Alden Standard.

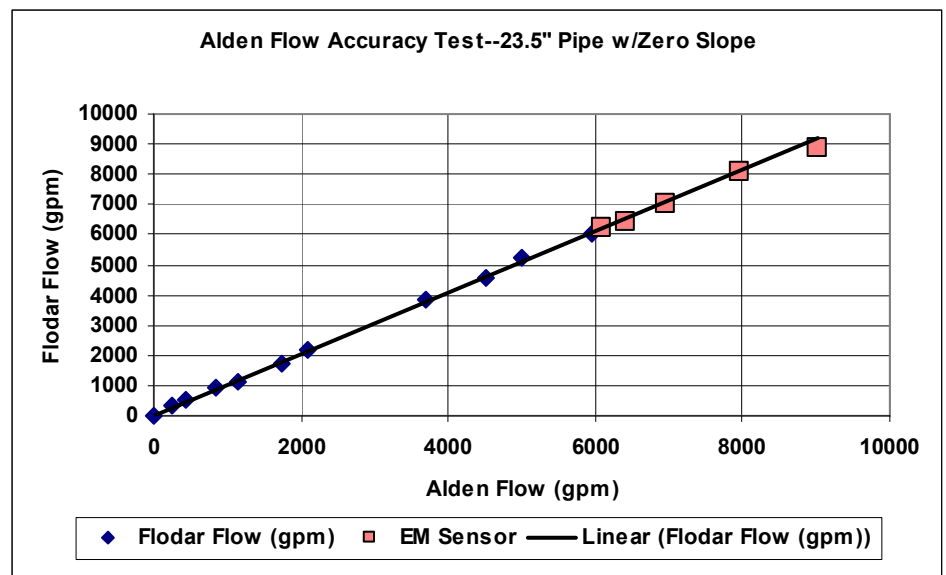


Figure 4 compares the Flo-Dar flow vs. the Alden Standard (weigh tank). The flow condition for this test was both open channel flow and surcharge (submerged) flow.

Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard.

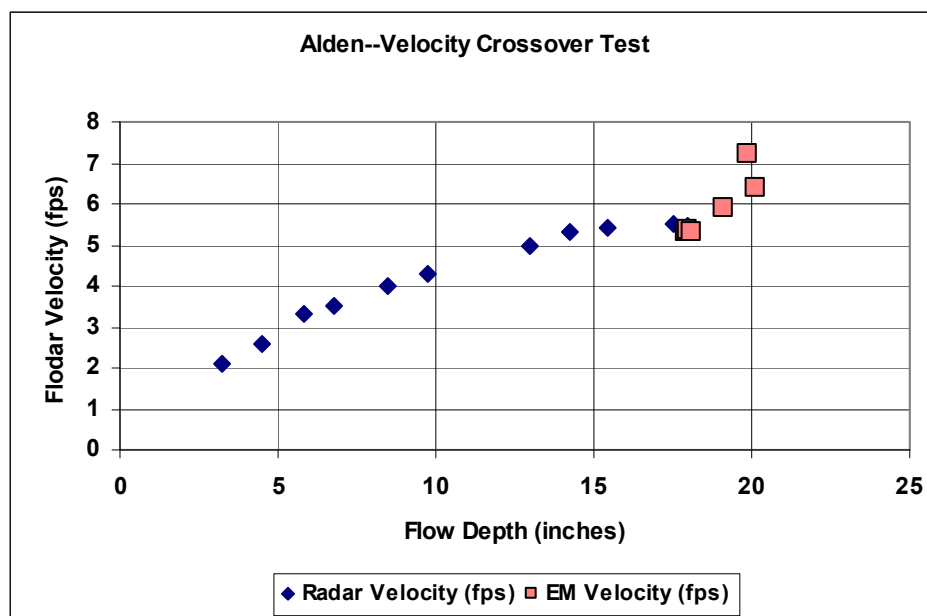


Figure 5 compares the velocity measured by the Radar sensor plotted against flow depth. Note that when the depth reaches approximately 18 inches the EM surcharge sensor has been activated. There is one data point where both sensors are active and then the EM surcharge sensor continues to measure after the radar sensor has become submerged and inoperative.

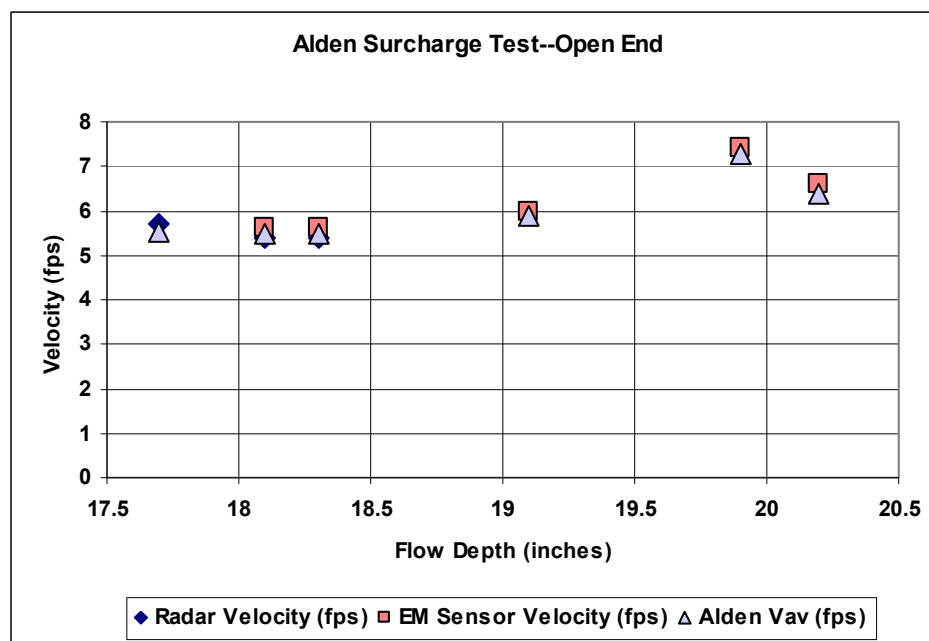


Figure 6 depicts a second surcharge test where the flow was incremented more slowly in order to achieve additional data points in the area where both the Radar sensor and the EM surcharge sensors are active simultaneously. Note that both the Radar sensor and the EM sensor are active between flow depths of 18 inches and 18.5 inches. Also, note how both the Radar and EM data points overlay each other and the Alden standard.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

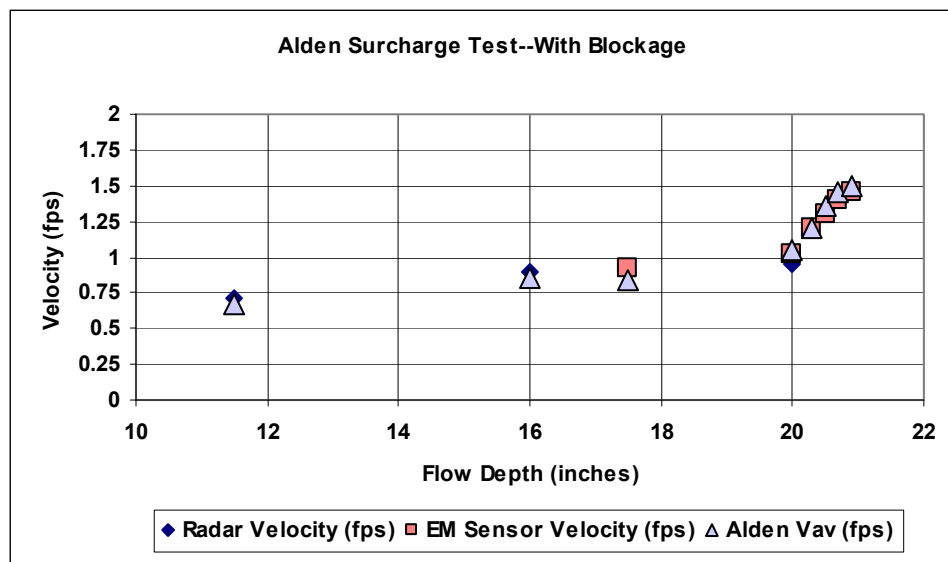


Figure 7 depicts the result of a surcharge test at a lower flow rate. In this test, a round plate with multiple holes was placed at the outlet of the test pipe so as to achieve submerged flow at a lower velocity. Note the consistency of both the Radar velocity data and the EM velocity data as compared to the Alden standard.

Additional tests performed at Alden in 2003 on a 36" pipe again validated Flo-Dar's accuracy under open channel and surcharge flow.

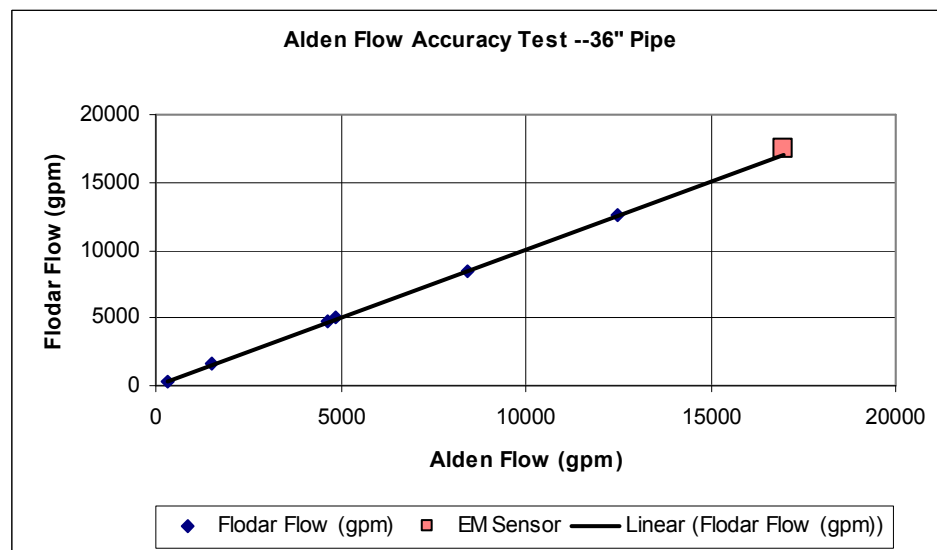


Figure 8 compares the Flo-Dar flow vs. the Alden Standard (weigh tank) for flow accuracy tests in a 36" pipe. These tests were performed on July 17, 2003. Note that at 17,000 gpm the sensor was under surcharge conditions. All of the data points were shown to be within 3.5% of the Alden Standard.

Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors.

Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The Flo-Dar data logger records all four of the flow parameters - open channel surface velocity and depth, and surcharged velocity and depth. When the water depth is below the bottom of the Flo-Dar sensor, only the surface velocity and the flow depth of the open channel flow are used in the flow calculation.

Once the flow depth is such that both the surcharge depth sensor is activated and a conductivity switch is activated, then flow is calculated using the full pipe dimensions for area and the surcharge velocity sensor for velocity.

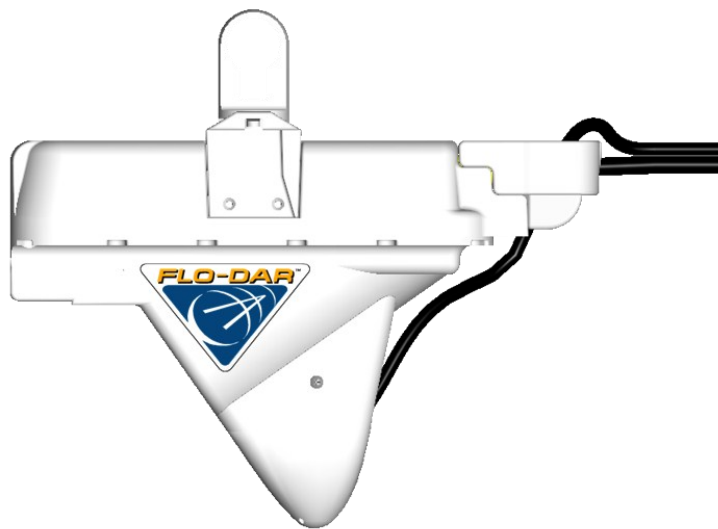
Conclusions

Flo-Dar is a rugged, general purpose flow meter for use in most open channels such as sanitary sewers, storm water sewers and other man-made channels such as aqueducts as well as certain natural channels such as small streams. Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors. Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

Note 1. The accuracy of open channel flow meters can be affected by adverse conditions present at any metering site. The accuracy specifications of most manufacturers are generally stated under ideal conditions.

Open Channel Flow Monitoring **Study**



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1) Locate the following parts (See Figure 1):

- | | |
|--------------------------------|---|
| 1) Flo-Dar Sensor | 7) Extension Pipe, Tee Fitting, and Bushing |
| 2) Flo-Dar Logger | 8) Clamp Set with qty. (8) 1/4-20 Bolts |
| 3) Flo-Dar Communication Cable | 9) Desiccant Capsule |
| 4) Flo-Ware Software CD | 10) Laser-Alignment Tool |
| 5) Sensor Mounting Frame | 11) Installation & Operations Manual |
| 6) Jack-Bar Assembly | 12) Start-Up Guide (not pictured) |



Figure 1

Methods & Procedures

2) Flo-Ware Software Configuration.

1. Insert the “Flo-Ware For Windows Resources CD” into your drive.
2. Select (single-click) “floware4.exe” from the “Software” box on your screen.
3. Select “Save” from the “File Download—Security Warning” screen.
4. Select “Save” from the “Save As” screen.
5. Select “Run” from the “Download Complete” screen.
6. Select “Run” from the “Internet Explorer—Security Warning” screen.
7. An installation wizard will initiate and load the files onto your hard drive.
8. Select the language you want to use from the “Select Language” screen.
9. Select “Next” from the “Welcome” screen.
10. Select “Next” from the “Choose Destination Location” screen.
11. Select “Next” from the “Select Components” screen.
12. Select “Next” from the “Start Installation” screen.
13. Select “Finish” from the “Installation Complete” screen.
14. Scroll down the screen and find “Flo-Dar / SVS” on the left side of the screen. Select (single-click) “flodar.exe” from that box on your screen
15. Select “Run” from the “File Download—Security Warning” screen.
16. Select “Run” from the “Internet Explorer—Security Warning” screen.
17. An installation wizard will initiate and install the files onto your hard drive.
18. Select “Finish” from the “Flo-Dar / SVS File Driver Installation” screen.

NOTE: There are ample help files on the “Flo-Ware for Windows Resources CD”

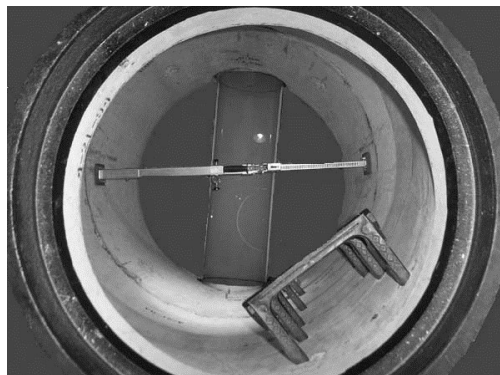
3) Set up the mounting frame and jack-bar assembly.

- A) Install the jack-bar assembly in the manhole. As a general rule, the jack-bar should be approximately 20” to 24” above the crown (top) of the pipe. In order to reduce movement of the jack-bar due to the cantilever action of the sensor, the jack-bar should be located as parallel to the pipe and invert of the manhole as possible.

MOST Desirable Jack-Bar Mount



LEAST Desirable Jack-Bar Mount



B) Assemble the frame, clamp-set, bushing, tee, and extension as shown in figure 2. Position the frame as close as possible to the lip of the pipe by sliding the assembly along the jack-bar with the slide. Be sure to secure the set-screw.

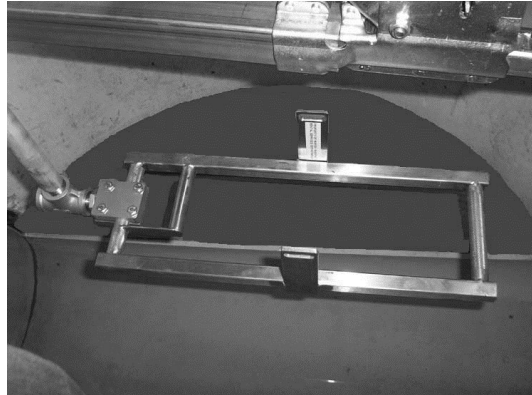


Figure 2

C) Set the elevation of the frame (measured to the top of the frame tubes) to be 6" above the inside crown of the pipe (for pipe I.D. under 25") or 5" above the inside crown of the pipe (for pipe I.D. of 25" and greater). An easy way to set the frame elevation is to measure the distance from the bottom of the manhole invert to the top of the mounting frame tubes. (This assumes that there is no drop or hydraulic jump from the lip of the pipe to the invert) Set the dimension to equal the pipe I.D. plus 6" (for pipe I.D. under 25") or the pipe I.D. plus 5" (for pipe I.D. of 25" or greater).



Figure 3

D) If you are not interested in measuring flow under surcharge conditions, or if you are sure the site will not surcharge, you can mount the sensor at any elevation above the surface of the water as long as the frame is within 60" of the water surface. When the sensor is mounted at higher elevations than those shown in Figure 3, it will still read normal velocity and level readings. Surcharge level will still be recorded properly, but surcharge velocity readings will not be possible. If you are mounting the sensor at higher elevations, it is still necessary to confirm the location of the velocity radar beam as described on pages 5 & 6 of this guide.

- E) Align and level the frame by placing the laser alignment tool in the frame as shown in figure 4. Utilize the bubble-level on the tool to level the frame.

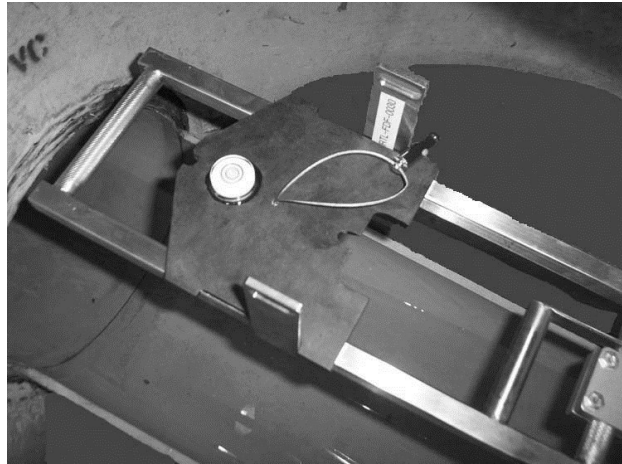


Figure 4

- F) Snap the laser-pointer into the laser alignment tool as shown below in figure 5. It is a tight fit. Make sure the pointer is firmly and evenly seated in its slot as shown.



Figure 5

- G) With the laser-pointer snapped into the tool, as shown, place the alignment tool back into the frame. The laser is now set up to duplicate the velocity radar beam angle. Use the laser-pointer to shine the beam onto the surface of the water. Ideally, the beam should be aligned so that it lands in the middle of the surface of the water inside the pipe.

NOTE: There are numerous adjustment points on the frame and jack-bar assembly.

- H) Remove the laser-pointer from the tool and re-install it into the tool as shown below in figure 6. With the laser-pointer in the position shown, it is now set up to duplicate the ultra-sonic level transducer beam location.
- I) Align the beam so that it lands in the middle of the channel you are measuring.

NOTE: You may have to check level, velocity laser alignment, and level laser alignment several times to ensure all three are correct. Adjusting one or more of the alignments will often affect one or more of the other adjustments! It is critical to remember to tighten all bolts on the jack-bar and clamp set to assure that the sensor frame does not move, once positioned correctly.



Figure 6

4) Install the Sensor.

- A) Gently lower the sensor into the mounting frame and lock it in place by rotating the bail assembly (located on top of the sensor) 90 degrees. The two locking arms will extend out to engage the slots in the vertical side webs of the frame ensuring that the sensor will not dislodge from the frame, particularly if the manhole surcharges.

NOTE: Make sure the sensor is placed in the frame so that the cables are exiting the sensor on the downstream (manhole effluent) side. (see Figure 7 below)

5) Connect the Data Logger.

- A) Connect the sensor cables to the data logger. Make sure the grey cable-end connects to the connector marked grey. Connect the yellow cable-end to the connector marked yellow. Tighten the threaded cable connector-ends securely to the data logger connectors.
- B) Remove the desiccant capsule from the vacuum-sealed bag and plug it onto the brass A.P.R. fitting (located next to the yellow cable connector) on the data logger. See Figure 8 below.



Figure 7



Figure 8

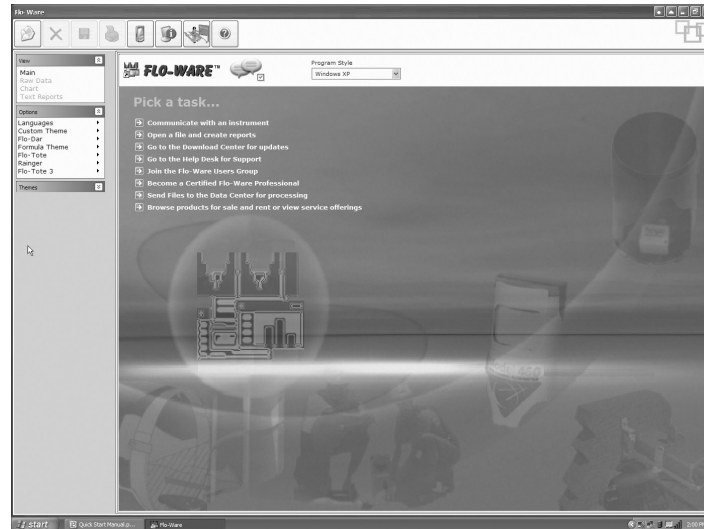
6) Configure the Data Logger using Flo-Ware Software.

A) Connect the interface cable from the data logger to the laptop's 9-pin serial port.

NOTE: If your laptop does not have a 9-pin serial port, you will have to use a USB port with a USB-to-serial port adapter (not provided by Marsh-McBirney).

B) Double-click the "Flo-Ware" icon on your computer's desktop.

C) When Flo-Ware opens, you will see the screen shown below.



D) Place your cursor on the line that says "Communicate with an instrument" and single-click. A small pop-up window will open. Place your cursor over the "Flo-Dar" line and single-click. A second pop-up window will appear. Single-click on the word "communications". The site set-up screen will appear as shown below.

The screenshot shows the 'Site Setup' dialog box. It has tabs for 'Site Setup', 'Read Meter', 'Real Time', 'View Data', 'Preferences', and 'Add-In'. The 'Site Setup' tab is active. It contains fields for 'Site ID' (a dropdown), 'Location' (a text box), 'Cycle Time' (15 min), 'Samples' (1 per cycle), 'Flow Unit' (MGD), 'Start Type' (Immediate), 'Multiplier' (1.00), 'Memory' (Fixed), 'Shape' (Circular), 'Diameter' (10.00 in), 'Sediment' (0.00 in), 'Sensor Offset' (12.00 in), and 'S/N'. There are 'Save Site', 'Delete Site', 'Read Setup', and 'Send Setup' buttons. A 'Calc...' button is next to the 'Sensor Offset' field. An 'Extended Setup' dropdown is also present. On the right side, it shows 'File Driver Ver. 3.1.0.0' and 'Firmware Ver.'. At the bottom, there is a 'Channels' table and a 'User' field set to 'Quality Control'. The 'Channels' table has columns for 'Name', 'Logging', and 'Unit'.

Name	Logging	Unit
Velocity	On	Feet Per Second
Level	On	Inches
Temperature	Off	Celsius
Surcharge Level	Off	Inches

At the bottom right are 'OK' and 'Cancel' buttons.

- E) Proceed to enter your specific site information into the appropriate boxes in the site set-up screen. An example of a typical set-up is shown below, along with explanations-actions of the input required from the user.

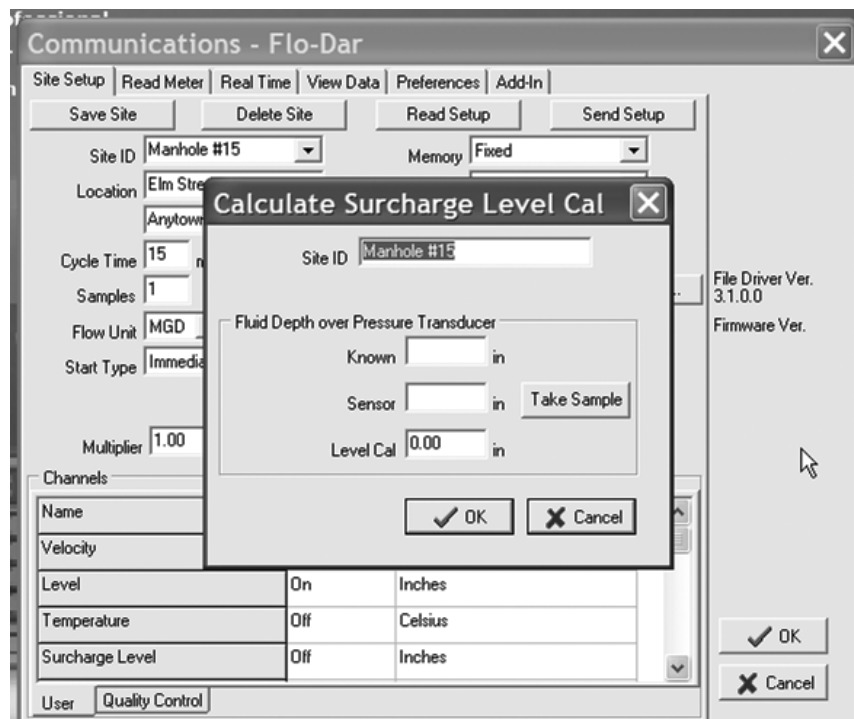
The screenshot shows the 'Communications - Flo-Dar' window with the 'Site Setup' tab selected. The window contains the following elements:

- Buttons:** Save Site, Delete Site, Read Setup, Send Setup, OK, Cancel.
- Fields:**
 - Site ID: Manhole #15
 - Location: Elm Street, Anytown, USA
 - Cycle Time: 15 min
 - Samples: 1 per cycle
 - Flow Unit: MGD
 - Start Type: Immediate
 - Memory: Fixed
 - Shape: Circular
 - Diameter: 24.00 in
 - Sediment: 0.00 in
 - Sensor Offset: 30.00 in
 - Multiplier: 1.00
- Channels Table:**

Name	Logging	Unit
Velocity	On	Feet Per Second
Level	On	Inches
Temperature	Off	Celsius
Surcharge Level	Off	Inches
- Other:** File Driver Ver. 3.1.0.0, Firmware Ver., Extended Setup button, Calc... buttons.

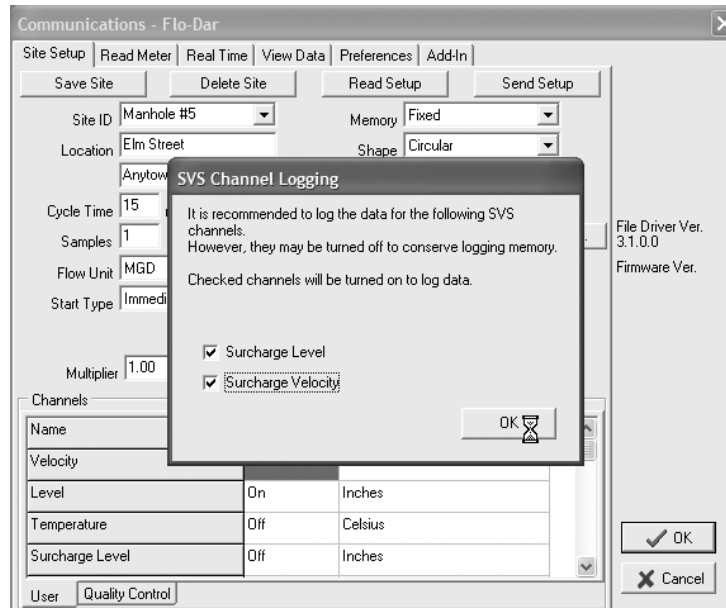
- Site I.D. and Location are self-explanatory. You **MUST** enter something in the site I.D. box in order for the program to work.
- Cycle time is the time interval between the start of each sample.
- Number of samples is the number of 1-minute samples that the instrument will take at the beginning of each cycle.
- Flow Units can be selected by using the pull-down arrow to view the available choices.
- Start Type is either immediate or delayed. If you choose a delayed start, you can use the pull-down arrow to reveal a calendar box and time box. You can use the pull down arrow on the calendar box to view convenient calendars which allow you to click on the date you desire. When using a delayed start, the instrument will “sleep” until the desired start-up date and time are reached. It will then “wake up” and start sampling.
- Multiplier should be left at 1.00 for most applications in round pipes. If you have a round pipe greater than 54” in diameter, or you are using the instrument in a square/rectangular channel, or an odd-shaped channel, contact the Customer Support Department at 714-542-1004 for instructions about the multiplier.
- Memory can be either “Fixed” or “Wrapped”. If you choose “Fixed”, the instrument will stop collecting data once the memory is full. In “Wrapped” mode, when the memory becomes full, the instrument will continue collecting data and will over-write the first data point, then the second, etc., with new data. This will continue indefinitely until a new set-up is downloaded to the instrument.

- Shape is self-explanatory. If you are measuring flow in an odd-shaped conduit, please call the US3 at 714-542-1004 for detailed instructions.
- Diameter is the INSIDE diameter of the pipe. This dimension should be measured in the field. Often, the pipe diameter is not what one assumes from the specs on a given pipe. Always measure the inside diameter to be sure of the dimension.
- Sediment is the amount of non-flowing sediment that may be in the bottom of the pipe. The software will take sediment into account when calculating cross-sectional area for the flow calculation. If there is no sediment, leave the number at 0.00.
- Sensor offset is the dimension from the top surface of the horizontal sensor mounting frame tubing, to the bottom of the invert or channel. (see Figure 3, page 4) If you want to measure flow in a surcharge condition, or if you want to set the instrument up to measure flow in case the manhole surcharges, then the mounting frame should be located so that the sensor offset dimension is equal to the pipe diameter plus 6 inches for pipe diameters up to 24", or equal to the pipe diameter plus 5 inches for pipe diameters greater than 24".
- Single-click on the "Extended Setup" button.
- Single-click on "Surcharge Level Cal"
- A window marked "Calculate Surcharge Level Cal" will appear as shown below.

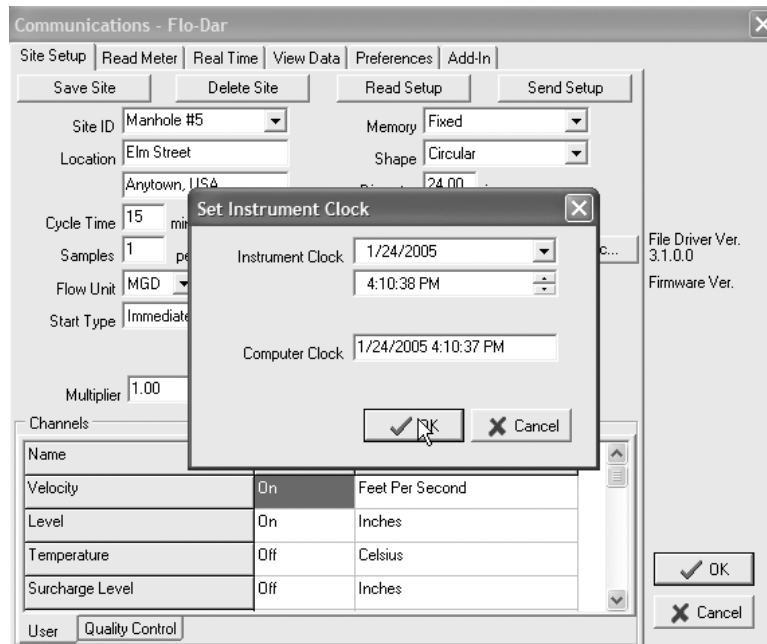


- Type 0.00 in the box marked "known".
- Single-click on the "Take Sample" box.
- Allow the unit to perform a real time sample of the surcharge pressure transducer. This will take approx. 45 seconds. The software will fill in the box marked "Sensor" and the box marked "Level Cal" with the proper values automatically.

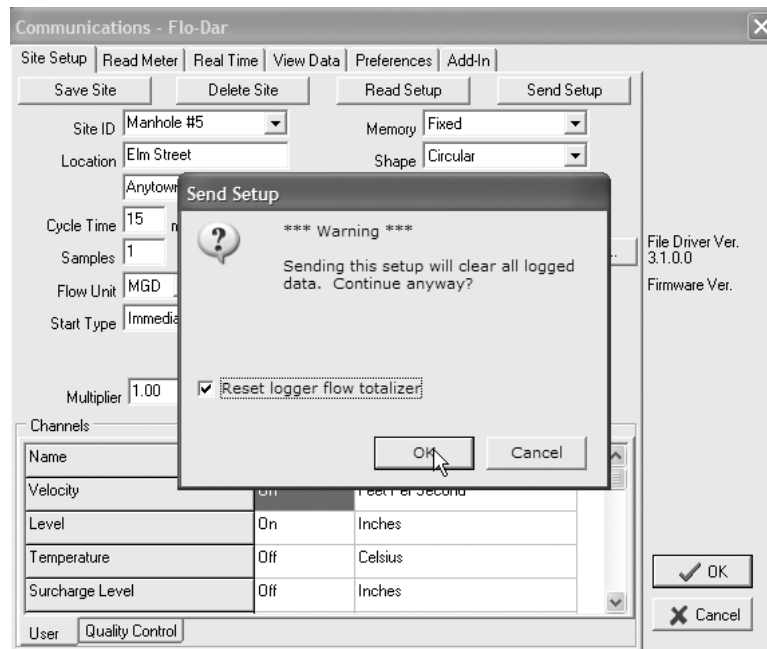
- 7) Save the site information to your hard drive by clicking on the “Save Site” button near the upper left-hand corner of the set-up screen.
- 8) Download the site information to the data logger by clicking on the “Send Setup” button near the upper right-hand corner of the site set-up screen.



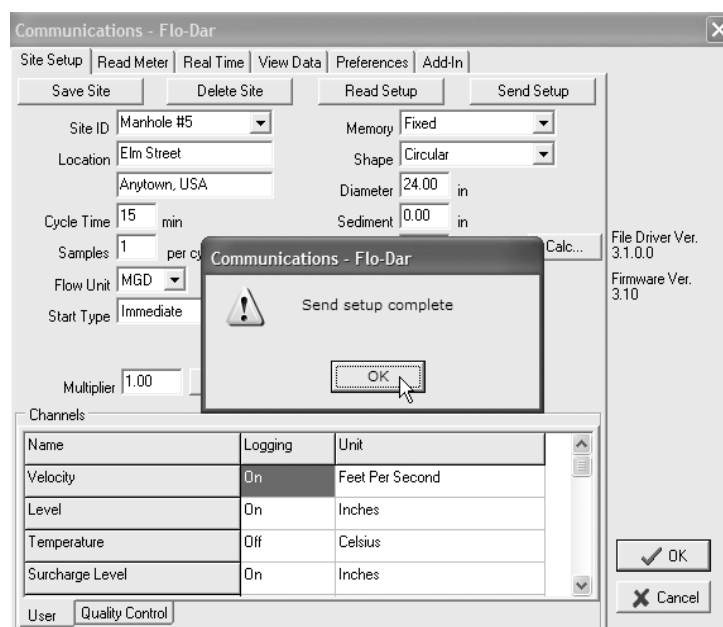
- 9) Turn on (check the boxes) both of the SVS channels as shown above.
- 10) Adjust the instrument clock to match your laptop computer clock as shown below. Use the pull-downs next to the date and time to help you set the instrument clock time. Click OK.



- 11) A warning screen will appear as shown below. Select whether or not you want to reset the logger flow totalizer, then click OK.

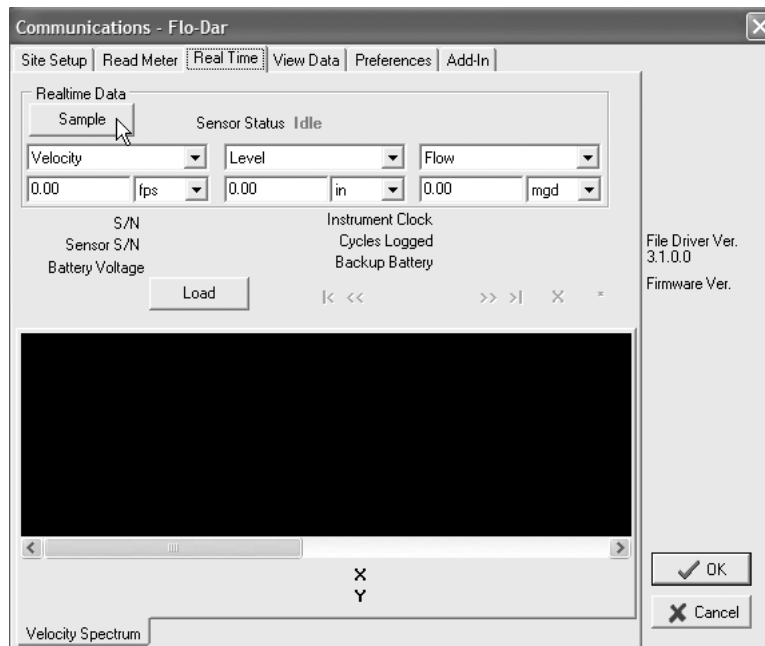


- 12) The “Send setup complete” screen (shown below) will appear, indicating that you have successfully sent the setup data to the instrument. The instrument will now begin collecting data.

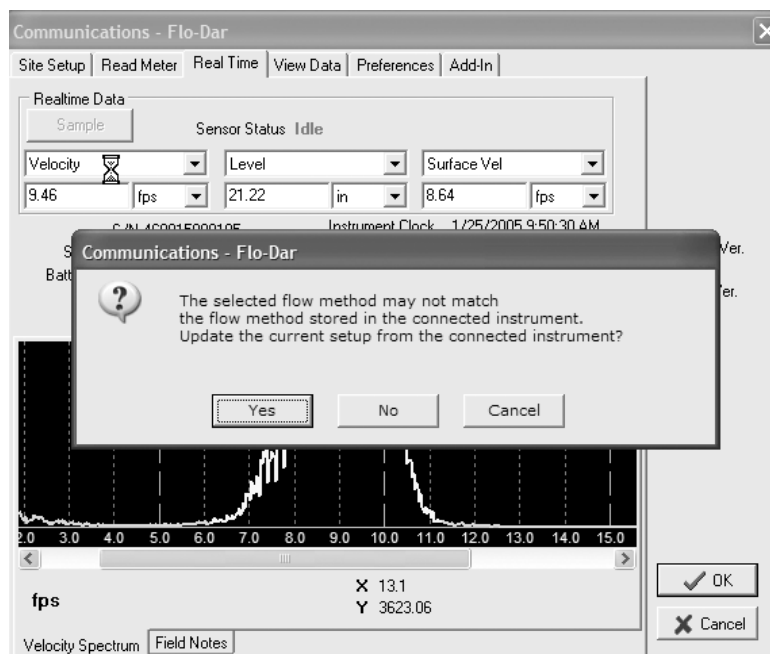


13) Collect real-time readings to confirm proper operation of the instrument before leaving the metering site.

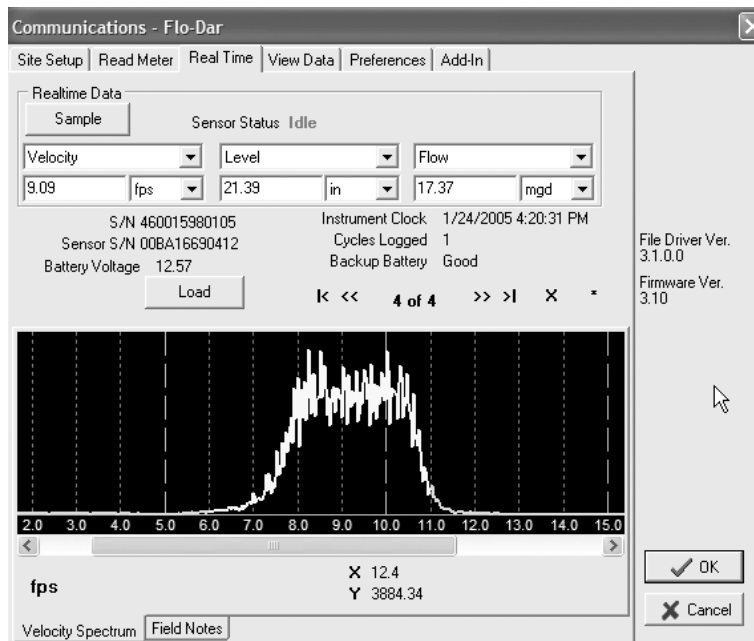
A) Single-click on the “Real Time” tab on the Communications Screen. The real time screen will appear as shown below.



B) Single-click on the “Sample” button. You may or may not see the following pop up window appear.



- C) Single-click the “Sample” button. It will take about 45 to 60 seconds for the meter to sample velocity, level, and send the data packet to the data logger. It will then display the real time sample on the screen (see below).



- D) Confirm the level reading on the screen matches the actual water level in the pipe.
Confirm that the velocity reading on the screen matches the velocity you approximate in the pipe.

- 14) Close the real time window and Flo-Ware main screen.
- 15) Disconnect the communications cable from your laptop to the data logger.
- 16) Screw the protective metal cap onto the communications port connector.
in order to protect the connector from damage due to water or dirt.
- 17) Coil the sensor cables and secure them to the top ladder rung. Hang the data logger from the top ladder rung. (See Figure 9 next page.)

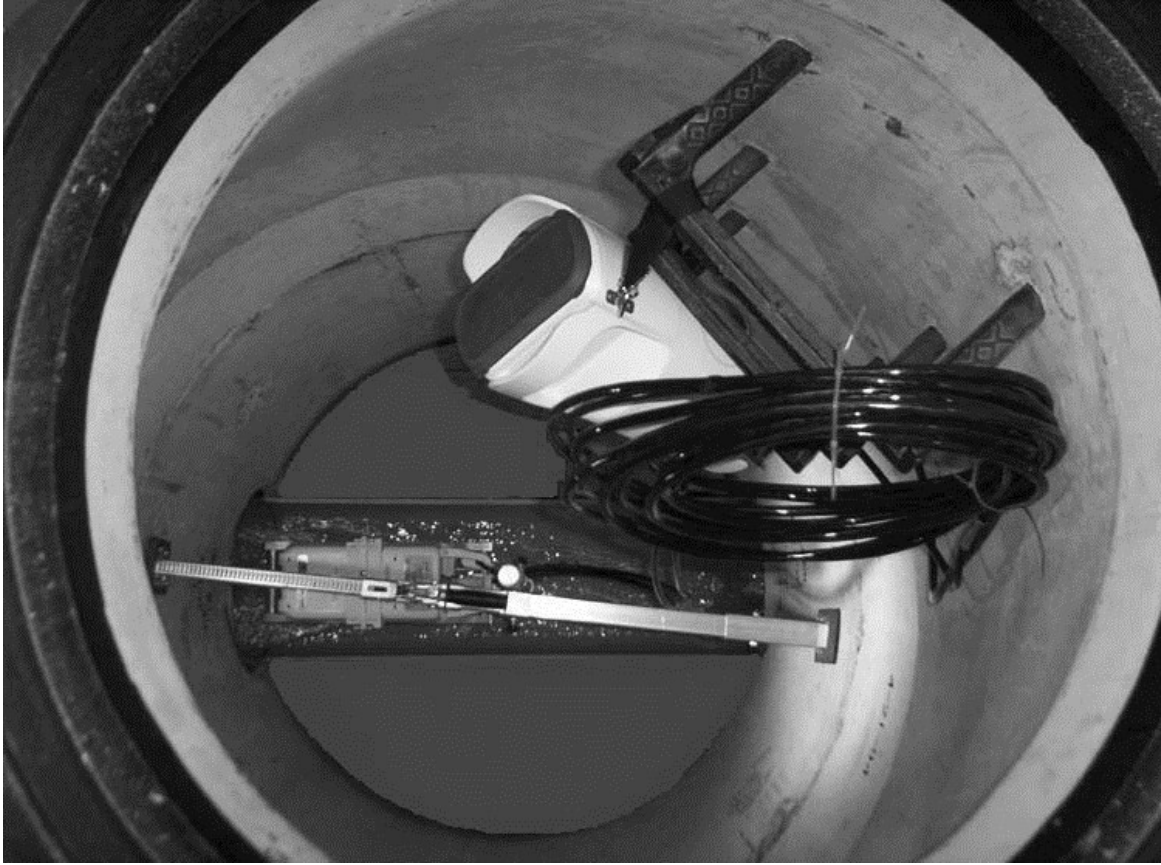


Figure 9

You have successfully installed the Flo-Dar Flowmeter. Please remember to secure the manhole lid prior to leaving the site.

If you have any questions regarding this flowmeter, please contact US3. Please note that telephone support is available Monday through Friday between 9:00 AM and 5:00 PM U.S. Pacific Standard Time.

Marsh-McBirney FLO-DAR® Area/Velocity Radar Flow Meter Sensor

FLOW



The Flo-Dar Sensor provides an ideal solution for non-contact, maintenance-free portable or permanent sewer flow monitoring.

Features and Benefits

The Flo-Dar Area/Velocity Radar Flow Meter provides a revolutionary approach to open channel flow monitoring. The sensor combines advanced Digital Doppler Radar velocity sensing technology with ultrasonic pulse echo depth sensing to remotely measure open channel flow. Use with FL900 Series Flow Logger or Flo-Logger/Logger XT for portable monitoring; for permanent monitoring sites, the Flo-Dar can be connected to the Flo-Station which displays flow rate, velocity, and level. (See Lit. No. 2709 [standard] or Lit. No. 2711 [wireless] for Flow Logger product information, or Lit. No. 2616 for Flo-Station product information). Intrinsically safe models available.

Accurate Flow Measurement

Flo-Dar provides the user with highly accurate flow measurements under a wide range of flows and site conditions. By measuring the velocity of the fluid from above, Flo-Dar eliminates accuracy problems inherent with submerged sensors including sensor disturbances, high solids content and distribution of reflectors.

Non-Contact Sensor Eliminates Lost Data

No lost data with non-contact, above the flow sensor that is unaffected by fouling due to debris and grease.

Easy Installation and Maintenance

As the sensor is mounted above the flow, personnel have little or no contact with the flow during installation. Future sensor removal can be done without the need for confined space entry.

Independent Accuracy / Long-Term Stability Verification

Flo-Dar sensor accuracy and long-term stability (up to 3 years without need for site calibration) from low flow depths up to surcharge conditions has been independently verified

many times over the years including a formal evaluation by the Alden Research Laboratory, Inc. and recent field evaluations done by municipalities and consulting engineering firms.

Perfect Solution for Difficult Flow Conditions

Operates in the most difficult conditions including flows with high solids content, high temperature, shallow and caustic flows, large man-made channels, and high velocities up to 20 ft/s.

Optional Surcharge Velocity Sensor

During surcharge events Flo-Dar's optional electromagnetic sensor will continue to provide uninterrupted and accurate flow monitoring through dry and wet weather flows without the need for routine sensor cleaning or maintenance.

Applications

Municipal

- Sanitary Sewer Evaluation Studies
- Collection Systems
- Capacity Studies
- Combined Sewer Overflows
- Inflow and Infiltration (I&I) Studies
- Billing / Custody Transfer
- Plant Influent and Effluent

Industrial

- Process Waste
- Plant Influent
- Plant Effluent
- Non-contact Cooling Water
- Stormwater Monitoring and Compliance

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™

WW

IW

C

Specifications*

FLO-DAR SENSOR

Enclosure

IP68 Waterproof rating, Polystyrene

Dimensions

160.5 W x 432.2 L x 297 D mm (6.32 x 16.66 x 11.7 in.), with SVS, D = 387 mm (15.2 in.)

Weight

4.8 kg (10.5 lbs.)

Operating Temperature

-10 to 50°C (14 to 122°F)

Storage Temperature

-40 to 60°C (-40 to 140°F)

Power Requirements

Supplied by FL900 Flow Logger, Flo-Logger, or Flo-Station

Interconnecting Cable

–Disconnectable at both sensor and logger or Flo-Station

Polyurethane, 0.400 (±0.015) in. diameter; IP68
Standard length 9M (30 ft), maximum 305 m (1000 ft)

Cables are available in two styles:

–connectors both ends
–connector from sensor with open leads to desiccant hub, desiccant hub with connector to logger. A potting/sealant kit will be included. This can be used to run the cable through conduit.

Important Note: The sensor cable assembly with desiccant hub is compatible with either the Marsh-McBirney Flo-Logger/Logger XT or the Hach FL900 Series Flow Loggers. When using this cable assembly with the Marsh-McBirney Flo-Logger, do not disconnect the desiccant cartridge that is attached to the Flo-Logger itself. It is important to keep the air tube plugged.

If using Flo-Dar cable with Flo-Station, the cable will have bare leads to the Flo-Station (30 to 1000 ft. lengths) and there will be no desiccant hub, as the air tube terminates inside of the Flo-Station housing.

Warranty

1 year

Set-up/Data Retrieval

Flo-Ware for Windows software is the user on-site set-up, data management, and report generation software. It is compatible with desktop/laptop computers utilizing Windows operating system.

Certification

The Flo-Dar Transmitter is certified to the following requirements:

- Transmitter type: Field Disturbance Sensor
- Frequency: 24.125 GHz - Doppler pulse
- Maximum rated power output: 128 dbuV (ave) @ 3 meters

Certified to: FCC Part 15.245: FCC ID: VIC-FLODAR24
Industry Canada Spec. RSS210. v7: IC No.: 6149A-FLODAR24

Use of this device is subject to the following conditions:

1. There are no used serviceable items inside this device.
2. The user must install this device in accordance with the supplied installation instructions and must not modify the device in any manner whatsoever.
3. Any service involving the transmitter must only be performed by Hach Company.
4. The user must ensure that no one is within 20 cm of the face of the transmitter when operating.

SURCHARGE DEPTH MEASUREMENT

Auto zero function maintains zero error below 0.5 cm (0.2 in.)

Method

Piezo-resistive pressure transducer with stainless steel diaphragm

Range

3.5 m (138 in.), overpressure rating 2.5 x full scale

VELOCITY MEASUREMENT

Method

Radar

Range

0.23 to 6.10 m/s (0.75 to 20 ft/s)

Frequency Range

24.075 to 24.175 G-Hz, 15.2mW (max.)

Accuracy

±0.5%; ±0.03 m/s (±0.1 ft/s)

DEPTH MEASUREMENT

Method

Ultrasonic

Standard Operating Range from Flo-Dar Housing to Liquid

0 to 152.4 cm (0 to 60 in.)

Optional Extended Level Operating Range from Transducer Face to Liquid

0 to 6.1 m (0 to 20 ft.) with 43.18 cm (17 in.) dead band, temperature compensated.

Accuracy

±1%; ±0.25 cm (±0.1 in.)

FLOW MEASUREMENT

Method

Based on Continuity Equation

Accuracy

±5% of reading typical where flow is in a channel with uniform flow conditions and is not surcharged, ±1% full scale max.

SURCHARGE CONDITIONS DEPTH/VELOCITY

DEPTH (Std with Flo-Dar Sensor)

Surcharge depth supplied by Flo-Dar sensor.

VELOCITY (Optional Surcharge Velocity Sensor)

Method

Electromagnetic

Range

±4.8 m/s (±16 ft/s)

Accuracy

±0.15 ft/s or 4% of reading, whichever is greater.

Zero Stability

> ±0.05 ft/s

CERTIFICATION INTRINSICALLY SAFE

The Flo-Dar and Surcharge Velocity Sensors are certified to Class I, Zone 1 Standards. They conform to ANSI/UL 60079-11 and are certified to CAN/CSA E60079-11 and EN 60079-11 standards.



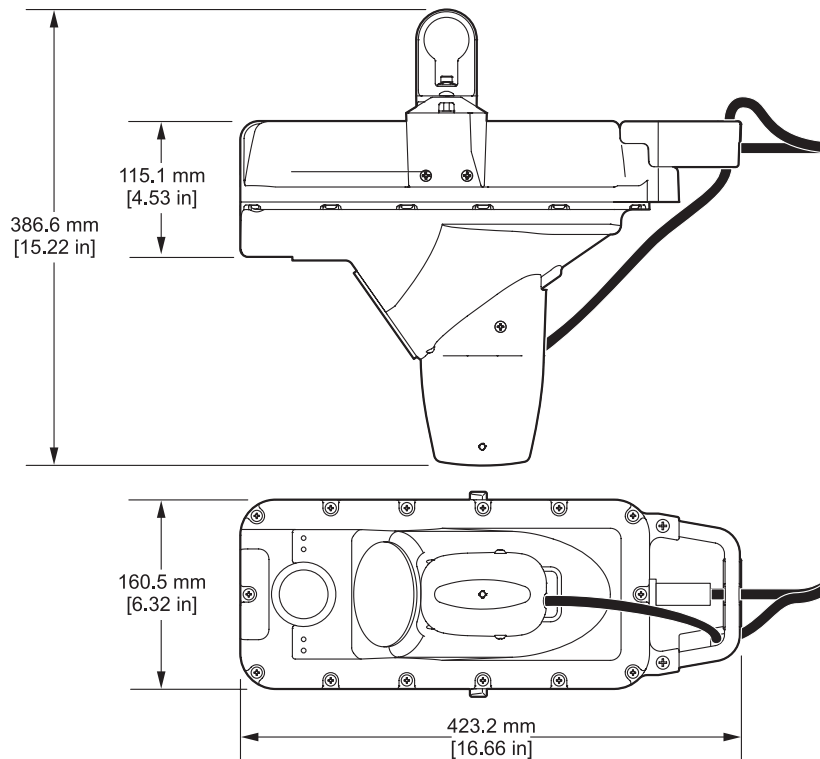
The Flo-Dar sensor meets CE requirements.

*Specifications subject to change without notice.

Engineering Specifications

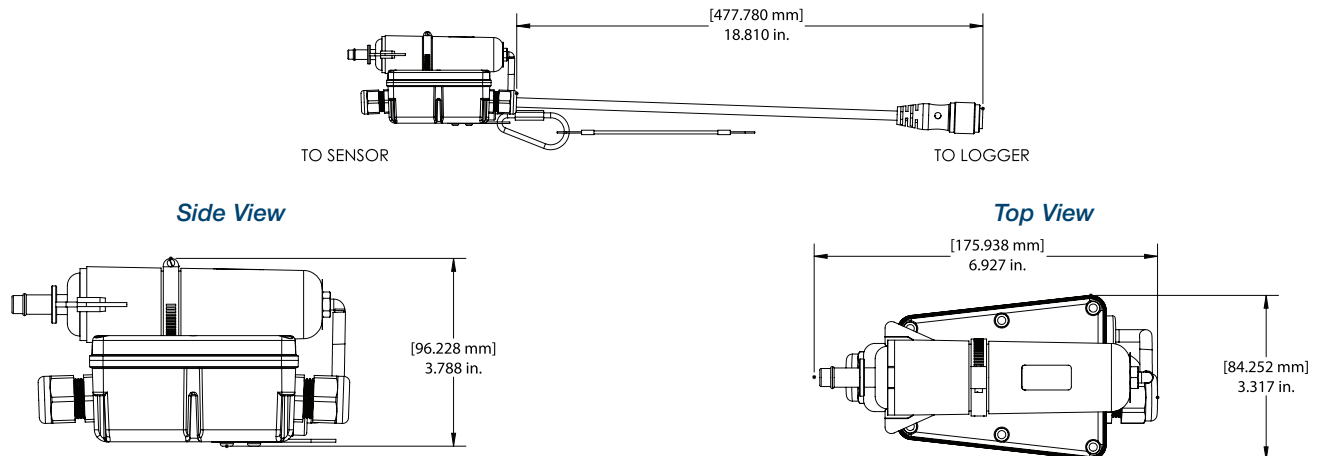
1. The flow meter shall be capable of measuring level, average velocity and surcharge depth.
2. The method of velocity measurement shall be Doppler radar.
3. The sensor shall combine advanced Doppler Radar velocity sensing technology with ultrasonic pulse echo depth sensing to remotely measure open channel flow.
4. Flow shall be calculated based on the Continuity Equation ($Q=V \times A$), where Q =Flow, V =Average Velocity and A =Area.
5. The range of velocity measurement shall be 0.23 to 6.10 m/s (0.75 to 20 ft/s).
6. The method of depth measurement shall be ultrasonic.
7. The standard operating range for depth measurement shall be 0 to 152.4 cm (0 to 60 in.) with an optional operating range of 0 to 6.1 m (0 to 20 ft.) with 43.18 cm (17 in.) deadband, temperature compensated.
8. The flow meter shall have a surcharge condition velocity sensor option.
9. Exterior dimensions of the sensor shall not exceed 160.5 W x 432.2 L x 297 D mm (6.32 W x 16.66 L x 11.7 D in.) or 160.5 W x 432.2 L x 387 D mm (6.32 W x 16.66 L x 15.2 D in.) with Surcharge Velocity option.
10. The sensor shall be able to measure bi-directional surcharge flow.
11. Optional Intrinsically Safe models available for flow monitoring in hazardous locations.
12. The model shall be the Marsh-McBirney Flo-Dar Open Channel Flow Meter Sensor.

Dimensions



Flo-Dar Area/Velocity Radar Flow Meter

The desiccant hub assembly includes a junction box to connect sensor cable to the desiccant and subsequently to the FL900 Logger. The desiccant can easily be replaced without need to purchase a separate desiccant module.



*Desiccant Hub Assemblies for use with portable FL900 Series Loggers and Flo-Logger.
(Sensor cable for use with Flo-Station will not contain a desiccant hub and will have bare wires on cable end.)*

Ordering Information

Configure FLO-DAR Sensor to Logger (Portable)

Flo-Dar Sensor	Model 4000	—	4	X	X
Flo-Dar Sensor with specified cable length (need to add cable as separate line item)			4		
Non Intrinsically Safe Surcharge Velocity Sensor Option (IMPORTANT NOTE: SVS cable length MUST MATCH FloDar Sensor Cable length)				0 3	
Non Extended Range Extended Range Option —Allows use in flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60". SVS Option requires Remote Extended Range below. Remote Extended Range Option with 6' sensor cable —Flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60".					0 1 2

Configure FLO-DAR Sensor to Flo-Station (Permanent)

Flo-Dar Sensor	Model 4000	—	9	X	X
Flo-Dar Sensor with specified cable length (need to add cable as separate line item)			9		
Non Intrinsically Safe Surcharge Velocity Sensor Option (IMPORTANT NOTE: SVS cable length MUST MATCH Flo-Dar Sensor Cable length)				0 3	
Non Extended Range Extended Range Option —Allows use in flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60". SVS Option requires Remote Extended Range below. Remote Extended Range Option with 6' sensor cable —Flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60".					0 1 2

Cables

FD9000CBL-XXX*	FL900 Series Logger to Flo-Dar sensor. Cable w/two connectors.
FDJCTBOXCBL-XXX*	FL900 Series Logger to Flo-Dar sensor. Cable with connector to sensor, open end to desiccant hub, desiccant hub with connector to sensor. Includes finishing kit for potting/sealing desiccant hub. For use with conduit.
6000062XX*	SVS Sensor with connector for use with FL900 Series Logger.
570011800-XXX*	Flo-Station to Flo-Dar sensor Cable with one connector and bare leads.
Model 4000-9	
6000059XX*	SVS Sensor with bare leads for use with Flo-Station.

*Contact customer service for product numbers.

Available Cable Lengths (in feet)

30	125	225	400	700
60	150	250	450	800
75	175	300	500	900
100	200	350	600	1000

See Lit. No. 2709 (standard models) and Lit. No. 2711 (wireless models) for FL900 Series Flow Logger ordering information. See Lit. No. 2616 for Flo-Station ordering information.

Mounting Hardware

800016701	Permanent Sensor Mount-Includes sensor frame & all mounting hardware. Portable Sensor Mounts Available (Sizes 34-107") Contact Sales.
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Accessories & Spares

245000501	Sensor Retrieval Pole - Used to place and retrieve sensor from mounting bracket. Pole extends to 7.3 m (21 ft.)
510012701	Sensor Retrieval Hook - Used with Sensor Retrieval Pole
570011401	Grounding Strap (required with Retrieval Pole and Hook when used with IS units)
8755500	Bulk desiccant beads (1.5 pounds)

Lit. No. 2708 Rev 2

K11 Printed in U.S.A.

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In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.



At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

Make it simple.

Be right.

For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.

In the United States and all other countries except Europe, contact:

HACH COMPANY
4539 Metropolitan Court
Frederick, MD 21704-9452, U.S.A.
Telephone: 800-368-2723
Fax: 301-874-8459
E-mail: hachflowsales@hach.com
www.hachflow.com

In Europe contact:

Flow-Tronic
Rue J.H. Cool 19a
B-4840 Welkenraedt Belgium
Telephone: +32-87-899799
Fax: +32-87-899790
E-mail: site@flow-tronic.com
www.flow-tronic.com



Be Right™

Hach FL900 Series Cellular Wireless Flow Logger

FLOW

NEW!



When combined with the Flo-Dar or Flo-Tote 3 sensor, the Hach FL900 Series Wireless Flow Logger takes flow monitoring to a whole new level. With features that reduce site time and increase crew safety, the wireless flow monitoring system allows you to easily manage your flow data 24/7, as well as your budget.

WW

Features and Benefits

The FL900 Wireless Flow Logger provides users with a reliable, budget saving open channel wireless flow monitoring solution for open portable flow monitoring applications. Flow data is accessible 24/7 with Hach fsDATA web-based software. When combined with the Flo-Dar or Flo-Tote 3 sensor, the system will drastically reduce site time and increase safety for monitoring crews.

Increase Monitoring Crew Safety

With the time saving features designed into the FL900 Wireless Flow Loggers, crews spend less time in the manhole and less time on site to decrease monitoring costs while increasing the safety of flow monitoring crews.

Plug and Play Sensor Ports

The FL900 Series Flow Logger is available with 1, 2 or 4 sensor ports. The sensor ports are "plug and play"; the logger auto-detects the type of sensor connected (Flo-Dar, Surcharge Velocity Sensor or Flo-Tote 3) to allow customers maximum flexibility for their Hach flow sensor inventories.

Flow Monitoring Data at Your Fingertips with fsDATA™ Web-Based Software

Hach fsDATA web-based flow meter software is the ideal time-saving and economical solution for the management of your Hach wireless flow meters and data 24/7. With

fsDATA routine site visits to collect flow data are eliminated keeping flow monitoring crews safe. (See Lit. No. 2707 for additional information on fsDATA.)

Easy Installation/Versatile Mounting Options

The logger can be quickly attached to a wall, pole or manhole ladder in minutes. Users can choose to hang logger from standard carabiner or optional 4-bolt wall mount for pole, horizontal or vertical wall mount or ladder rung mount.

LED Gives Quick Confirmation of Logger Status

Get peace of mind the logger is ready to capture the next flow event, before you leave the site. The rugged FL900 Wireless Flow Logger includes a status LED panel. The indicator light on the top of the logger shows the status of the instrument and modem (if equipped with wireless option). The user can manually send a call to the server to make sure the network connection is good by simply swiping the magnet over the call initiation target.

IW

C

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™

Specifications*

FL900 SERIES FLOW LOGGER PORTABLE DC POWERED ELECTRONICS (Includes Models FL901, FL902 & FL904)

Dimensions (W x D x H)

25.4 x 22 x 40 cm (10.0 x 8.7 x 16.0 in.)

Enclosure

PC/ABS structural foam

Environmental Rating

NEMA 6P (IP68)

Weight (Using Model FL900)

4.5 kg (10 lb)—no batteries; 6.3 kg (14 lb)—2 batteries;
8.2 kg (18 lb)—4 batteries

Operating Temperature

–18 to 60°C (0 to 140°F) at 95% RH

Storage Temperature

–40 to 60°C (–40 to 140°F)

Power Requirements

8 to 18 Vdc from batteries or external power source,
2.5W max.

Battery Life at 15 minute logging intervals (at room temperature)

185 days with 4 lantern batteries and a Flo-Dar sensor,
306 days with 4 lantern batteries and a Flo-Tote sensor

The optional long life alkaline battery pack can be used to extend battery life, if the Flow Logger is ordered with the external power option connector.

LED Status Indicator

- Green Flashes every 3 seconds during normal operation.
Flashes every 15 seconds during sleep mode.
- Red Flashes when an attached sensor does not agree with the logger program, when an expected sensor is not found or the sensor is not working properly.

LED Modem Indicator

- Stays green during a call to the server. Goes blank after the call is successfully completed and terminated.
- Flashes red if the call to the server failed.

Sensor Ports

1, 2 or 4 ports

Connectors

Stainless steel connectors

Datalog Channels

16 maximum

Alarms

Maximum of 16 channel alarms including high/high, high, low, low/low and system alarms including low battery, low RTC battery, low slate memory, slate memory full.

Alarm Actions

Trigger sampler, change logging interval, change call interval, send an e-mail, or send text message (SMS).

Logging Intervals

1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes
Primary and secondary intervals for dynamic logging.

Data Storage

Event Log: 1,000 events maximum in non-volatile flash memory
Sample History: 2,000 sample events maximum in non-volatile flash memory
Datalog: 325,000 data points; 1128 days for 3 channels at 15-minute log intervals

Local Communication

USB

RS232 (Baud rates: 9600, 19200, 38400, 57600, 115200)

Remote Communication (optional)

Wireless modem; CDMA or GPRS technology with a mobile provider, CDMA2000 1xRTT or GPRS.

Protocols

Modbus RTU; Modbus ASCII; Mobile-Terminated SMS;
Mobile-Originated SMS; TCP/IP

Timebase Accuracy

±0.002%, synchronized every 24 hours with server software and modem

Supported Sensors

Flo-Tote 3, Flo-Dar, Flo-Dar with SVS, Rain Gauge

Sampler Interface

Compatible with Sigma 900 Standard, Sigma 900 Max, Hach SD900 to support set-point sampling, flow- pacing, and logging sample history.

Desktop Software

Flo-Ware for Windows software is required for programming the logger, data management, and report generation software. It is compatible with desktop/lap top computers utilizing Windows operating system. Minimum resolution needed is 1024x768.

Internet Application Software

FSDATA web-based software for flow meter data management and report generation for wireless flow meters and data access 24/7.

Certifications

Logger: CE; optional AC power supply: UL/CSA/CE

Warranty

1 year



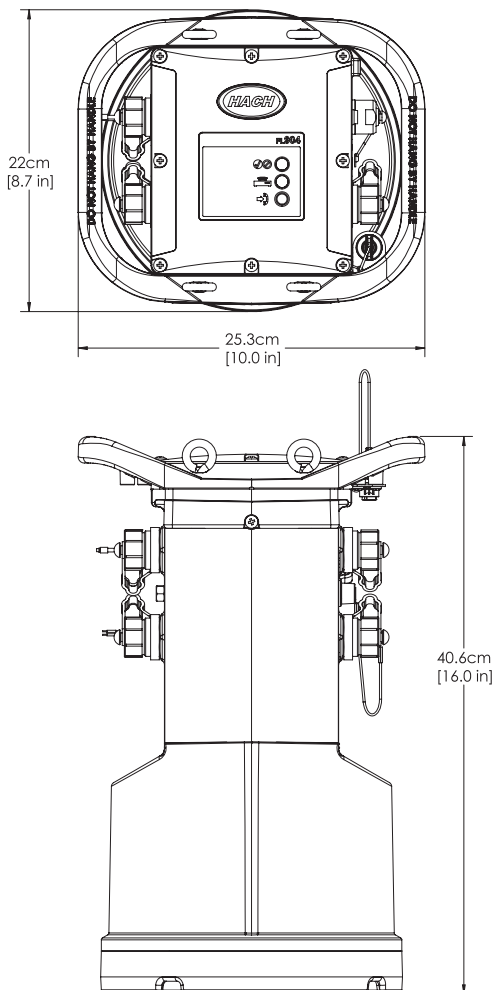
The FL900 Series Loggers meet CE requirements.

*Specifications subject to change without notice.

Engineering Specifications

1. Exterior dimensions of the Flow Logger shall be 25.4 W x 22 D x 40 cm H (10.0 W x 8.7 D x 16.0 in. H)
2. The Flow Logger enclosure material shall be PC/ABS structural foam with NEMA 6P (IP68) rating.
3. The operating temperature for the Flow Logger shall be -18 to 60°C (0 to 140°F) at 95% relative humidity and storage temperature of -40 to 60°C (-40 to 140°F).
4. Power requirements of the Flow Logger shall be 8 to 18 Vdc from batteries or external power source, 2.5W max.
5. When used with a Flo-Dar sensor, the Flow Logger shall have a battery life of 185 days utilizing 4 6v alkaline batteries at a 15 minute logging interval (at room temp.). When used with a Flo-Tote sensor, the Flow Logger shall have a battery life of 306 days utilizing 4 6v alkaline batteries at a 15 minute logging interval (at room temperature). A long-life battery for longer deployments shall be available option.
6. The Flow Logger shall have 1, 2 or 4 sensor ports with stainless steel connector, 1 communications port and 1 auxiliary port.
7. The Flow Logger shall have primary logging intervals of 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes.
8. The Flow Logger shall have secondary logging intervals available to modify the logging rate based on a defined channel alarm condition or trigger.
9. Optional remote communication shall be available on the FL900 Series Loggers via Wireless modem; CDMA2000 1xRTT or GPRS.
10. The Flow Logger data storage event log shall be 1,000 events maximum in non-volatile flash memory.
11. Timebase Accuracy of the Flow Logger shall be 0.002% synchronized every 24 hours with server software and modem.
12. The Flow Logger shall support the Flo-Dar, Flo-Dar with SVS, Flo-Tote 3 Sensors and Rain Gauge.
13. The Flow Logger shall be compatible with Sigma 900 Standard, Sigma 900 Max and Hach SD900 to support set point sampling, flow-pacing and sample history logging.
14. The Flow Logger shall be able to connect to a lap top or desk top PC using either USB or RS232 serial connection.
15. The Flow Logger shall have an LED indicator for operating /programming status visible on the topmost horizontal surface of the logger.
16. The internet data management software shall indicate sites in alarm condition in either a map view or list view.
17. When connected to an external power source, the FL900 series logger shall be capable of power switching, i.e. drawing power from the external source and conserving the alkaline batteries inside the logger base. At the time the external power source reaches a low alarm condition, it will then switch the power draw to the alkaline batteries mounted inside the base of the logger.
18. The internet software for flow data management shall be Hach FSDATA.
19. The logger will be a Hach FL901, FL902, or FL904 Flow Logger.

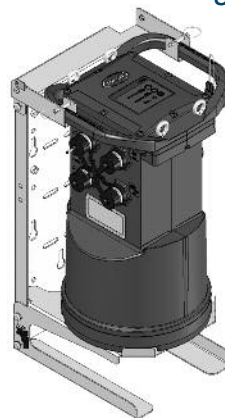
Dimensions



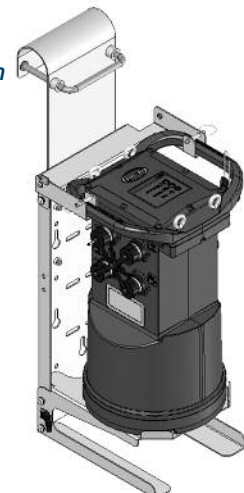
Installation/Mounting Options



*Flow Logger
Suspension Cable with
Carabiner (Standard)*



*Flow Logger Wall Mount
Prod. No. 8542700
(Optional)
K-115*



*Flow Logger Ladder Rung Mount
Prod. No. 854450
(Optional)*

Ordering Information

		Sensor Connector(s)	Country Code	Modem	Rain Gauge
FL90X Electronics (Flow Logger)	Model FL90	—	97	—	—
1 Sensor Connector		1			
2 Sensor Connectors		2			
4 Sensor Connectors		4			
None				X	
AT&T (Activated)				A	
GPRS no SIM				G	
Sprint (Inactive)				R	
Sprint (Activated)				S	
No Rain Gauge Connector					X
With Rain Gauge Connector					R

Cables

8528700	Cable, External power, 2 wire, 9 ft.
8528200	Cable, Communication, RS232
8528300	Cable, Communication, USB
8528400	Cable, Aux, 7pin MIL 5015 (Connect to Sigma Sampler), 9 ft.
8528401	Cable, Aux, 7pin MIL 5015 (Connect to Sigma Sampler), 25 ft

Antennas

5228400	Antenna, Half Wave (824-894, 1850-1990 MHz) —US for Verizon, Sprint, AT&T, T-Mobile (Is attached to Logger)
6241804	Antenna, Mini-Wing, Quad (824-960, 1710-2170 MHz) —US for Verizon, Sprint, AT&T, T-Mobile (Customer to Mount)
6683000	Antenna, Traffic Rated In Road/Burial (1850-1990 MHz) —US for use with Sprint only wireless service
6246200	Antenna, Traffic Rated In Road/Burial (824-896 MHz) —US for use with Verizon only wireless service
5255400	Antenna, Traffic Rated Manhole Lid (824-896, 1850-1990 MHz) —US for Verizon, Sprint, AT&T, T-Mobile

Software

Model T200-200	Flo-Ware Desktop Software
FS-HOSTING	Monthly data hosting service for FSDATA
FS-DATAXFR	Monthly wireless service

Mounting Hardware

8543800	Wall mount bracket (304 Stainless)
8545600	Wall mount bracket with ladder hanger (304 Stainless)
8542700	Wall mount bracket with AC Power Supply shelf (304 Stainless)
8544500	Wall mount bracket with AC Power Supply Shelf with ladder hanger (304 Stainless)

Replacement Parts

8755500	Desiccant refill beads, Bulk 1.5 lb
11013M	Battery, 6V lantern
8542900	Battery, long-life alkaline
8543000	Battery pack top cap adaptor and cable (for long-life alkaline battery pack 800017701)
8542800	Rain Gauge with 100 ft. cable

Lit. No. 2711

G101.5 Printed in U.S.A.

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In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.

At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

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For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.

In the United States and all other countries except Europe, contact:

HACH COMPANY
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Frederick, MD 21704-9452, U.S.A.
Telephone: 800-368-2723
Fax: 301-874-8459
E-mail: hachflowsales@hach.com
www.hachflow.com

In Europe contact:

Flow-Tronic
Rue J.H. Cool 19a
B-4840 Welkenraedt Belgium
Telephone: +32-87-899799
Fax: +32-87-899790
E-mail: site@flow-tronic.com
www.flow-tronic.com



Be Right™

User Instructions

Antennas for flow products

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.



Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/98/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.

Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.

Product components

Make sure that all components have been received. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Required equipment/software

Make sure that the following requirements are available:

- FL900 Series flow logger with modem option or Sigma 930T
- Remote host computer operating FSDATA or Telogers for Windows server software
- Portable computer operating FSDATA, FloWare or Telogers for Windows
- Activated wireless account

FL900 Series Flow Logger

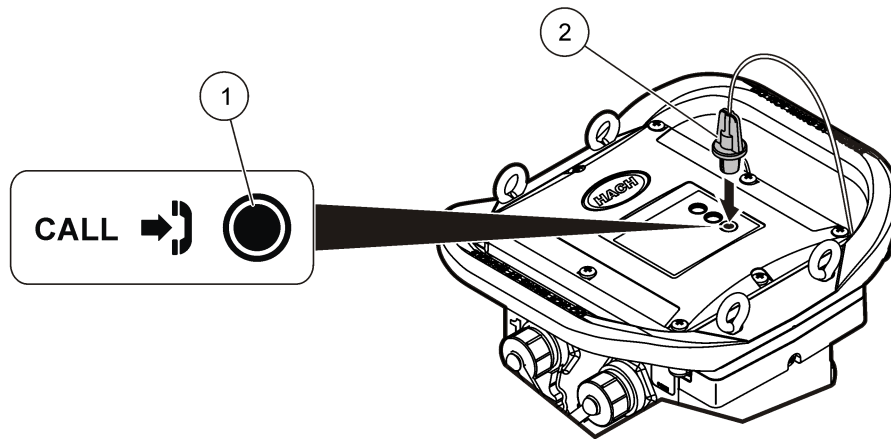
Verify the telemetry (wireless option)

The user can manually send a call to the server to make sure that the network communication is good.

1. Temporarily attach the antenna to the logger to test the antenna and the cell coverage at the site location before installation.
2. Touch the magnet to the call initiation target ([Figure 1](#)). The modem LED indicator changes to green.
3. Look at the modem LED indicator during the call (45 to 90 seconds) and wait for a change:
 - LED goes off—the connection to the server is good.
 - LED flashes red—the connection to the server failed.

Note: If the connection failed, refer to the instrument user manual for more information.

Figure 1 Call the server



1 Call initiation target

2 Magnet

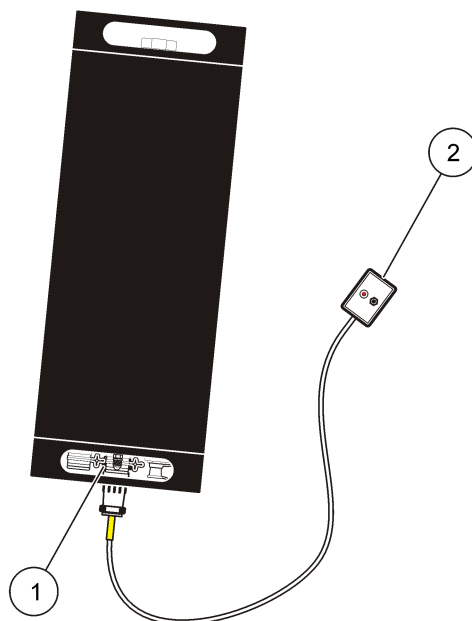
930T Flow meter

Verify the wireless connection

The tamper button is used to examine if the wireless connection is working.

1. Temporarily attach the antenna to the logger to test the antenna and the cell coverage at the site location before installation.
2. Attach the tamper module to the RS232 connector on the flow meter ([Figure 2](#)).
3. Push the tamper button to start a cellular call from the flow meter to the remote host computer.
4. Go to the event log in Telogers for Windows to make sure that the data was successfully downloaded from the flow meter to the remote host computer. Refer to the 930T documentation for further information about telemetry troubleshooting.

Figure 2 Tamper module connected to the 930T Flow meter



1 RS232 connector

2 Tamper module

Installation

⚠ WARNING

Electromagnetic radiation hazard. To meet the requirements of the FCC Grant, CE Mark and other regulatory bodies, do not use or install the device with an antenna that is not supplied by the manufacturer. Make sure that all antennas are kept at a minimum distance of 20 cm (7.9 in.) from all personnel in normal use.

NOTICE

Test the antenna and cell coverage at the site location before installation.

NOTICE

Make sure that the flow meter is programmed to call the host PC before installation.

Half wave antenna

NOTICE

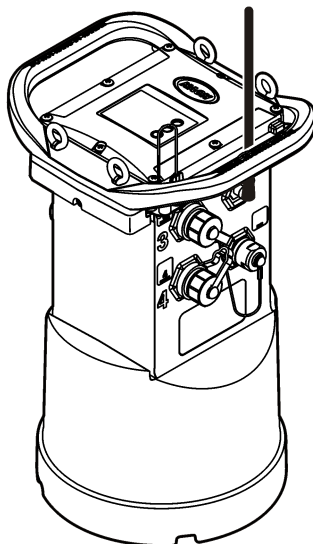
The half wave antenna is intended for above-ground use.

1. Unpack the antenna ([Figure 3](#)).
2. Bend the antenna at the joint to a 90 degree angle between the antenna and the swivel fitting.
3. Put the antenna extension inside of the logger handle ([Figure 4](#)).
4. Align the threads from the antenna fitting to the antenna receptacle on the logger. Hand-tighten by turning the swivel end.

Figure 3 Half wave antenna



Figure 4 Half wave antenna attached



Traffic rated manhole lid antenna

Required tools:

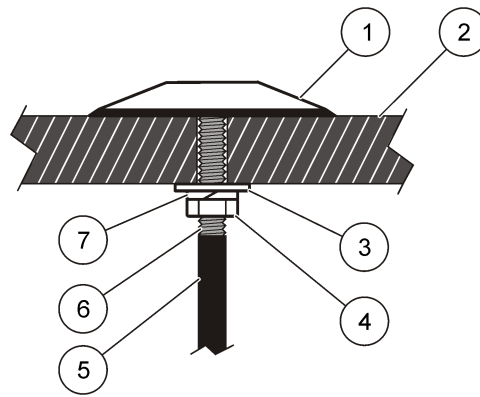
- 31.75 mm (1¼ in.) open-end wrench
- Large nylon Ty-wrap cable ties

1. Unpack the antenna ([Figure 5](#)) or disassemble the antenna from the instrument.
2. Make sure that the manhole lid has a 25.4 mm (1 in.) hole for the antenna neck to fit into.
***Note:** Do not use the pick hole. Use a drill, motor oil for lubrication and increasing size drill bits to drill the 25.4 mm (1 in.) hole if needed. Make sure that the location of the hole does not coincide with the ribs on the underside of the manhole lid.*
3. Remove the manhole lid and put the lid in a stable position where the lid top and bottom are accessible.
4. Remove the nut and washers from the threaded neck on the base of the antenna ([Figure 6](#)).
5. Put the antenna cable and neck through a hole on the manhole lid until the base of the antenna is against the top of the manhole lid.
6. Install the flat washer, then the lock washer and then the nut on to the threaded neck of the antenna.
7. Tighten the nut with the open-end wrench until both washers are flush against the base of the manhole lid and the antenna is tight ([Figure 6](#)).
8. Connect the antenna cable to the instrument connector labeled "Antenna". To make sure proper transmission, hand-tighten the connections.
9. Attach any excess cable to the access ladder or another non-obstructing location with Ty-wrap cable ties.
10. Replace the manhole lid.

Figure 5 Traffic rated manhole lid antenna



Figure 6 Manhole lid installation



1	Antenna top	5	Antenna cable
2	Manhole lid	6	Antenna threaded neck
3	Flat washer	7	Lock washer
4	31.75 mm (1¼ in.) nut		

Wing Quad antenna

The Wing Quad antenna can be attached to an interior wall or to a window for a longer term deployment or the antenna can be attached to a manhole lid for a short term deployment.

Required tools:

- Large nylon Ty-wrap cable ties

1. Unpack the antenna ([Figure 7](#)).
2. To attach the antenna to a window or a wall, remove the adhesive backing and push the antenna to a clean surface.
3. To attach the antenna to a manhole, make sure that the manhole lid has a hole large enough for the antenna connector to fit into.
Note: Do not use the pick hole. Use a drill, motor oil for lubrication and increasing size drill bits to drill the 1" hole if needed. Make sure that the location of the hole does not coincide with the ribs on the underside of the manhole lid.
4. Remove the manhole lid and put the lid in a stable position where the lid top and bottom are accessible.
5. Put the antenna cable and neck through a hole on the manhole lid until the base of the antenna is against the top of the manhole lid.
6. Attach the antenna to the manhole lid with heavy tape or tar tape.
7. Connect the antenna cable to the instrument connector labeled "Antenna". To make sure proper transmission, hand-tighten the connections.
8. Attach any excess cable to the access ladder or another non-obstructing location with Ty-wrap cable ties.
9. Replace the manhole lid.

Figure 7 Wing Quad antenna



Traffic rated in-road/burial antenna

Required tools:

- Asphalt saw or auger: saw capable of cutting 127 mm (5 in.) in diameter and 76.2 mm (3 in.) deep into a road surface or ground
- Asphalt chisel
- Hammer drill with 19.1 to 25.4 mm ($\frac{3}{4}$ to 1 in.) asphalt drill bit (for antenna cable installation)
- Sakrete asphalt mix (Asphalt patch)
- Bondo; Mar-Hyde P606 Traffic Detector Wire Loop Sealer or equal
- Shovel, if placing in the ground

The traffic rated in-road/burial antenna is intended for burial beneath the road surface or ground adjacent to a manhole or vault that is being monitored ([Figure 9](#)).

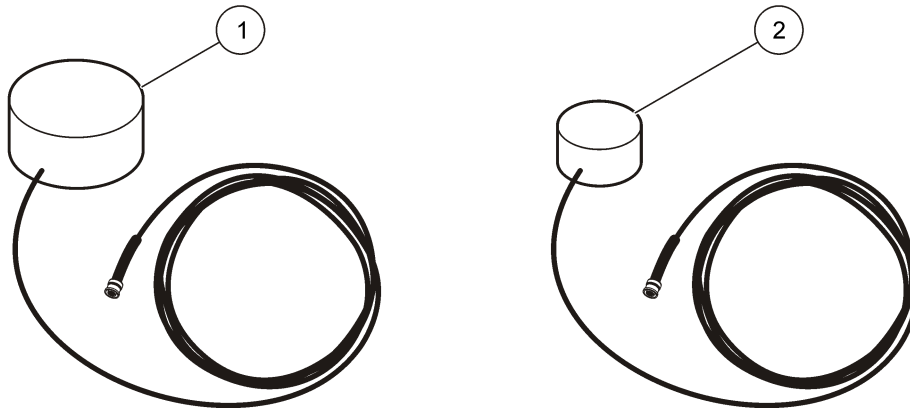
NOTICE

The antenna should be installed in the road approximately 152.4 to 203.2 mm (6 to 8 in.) inches from the manhole or vault containing the flow meter.

1. Unpack the antenna ([Figure 8](#)) or disassemble the antenna from the instrument.
2. Excavate a hole or trench in the road surface or ground approximately 127 mm (5 in.) in diameter (or square) and 76.2 mm (3 in.) deep.
3. Select the closest position from the excavated hole to the manhole. Drill a 19.1 to 25.4 mm ($\frac{3}{4}$ to 1 in.) hole from the selected position to the manhole. Make sure to drill the hole below the steel manhole cover support ring ([Figure 9](#), [List item](#) on page 7).
4. Put the antenna cable through the drill hole into the manhole or vault.
5. Install the antenna in the excavated hole. Pull the antenna cable taut. Locate the antenna so that the ceramic side of the antenna is approximately 6.4 ($\frac{1}{4}$ in.) to 12.7 mm ($\frac{1}{2}$ in.) maximum below the road or ground surface. Make sure the antenna sits safely in the hole.
6. Attach the antenna cable to the antenna connector.
7. Make sure that the antenna is working by placing a call from the instrument (refer to [Verify the wireless connection](#) on page 2).
8. When the operation of the antenna is confirmed, permanently bury the antenna.
 - a. Insert asphalt mix around the antenna and pack it in place. Make sure the antenna is sitting firmly on a solid base and cannot be rocked back and forth.
 - b. Install the asphalt mix around the antenna. The mix should be level with the road surface but not over the antenna surface.
 - c. Pour the Bondo sealer on and over the asphalt mix and over the top of the antenna. There should be no more than 6.4 mm ($\frac{1}{4}$ in.) of Bondo sealer over the top of the antenna.

- d. Connect the desired sensors and options to the flow meter. Calibrate the sensors and install the flow meter in the manhole.

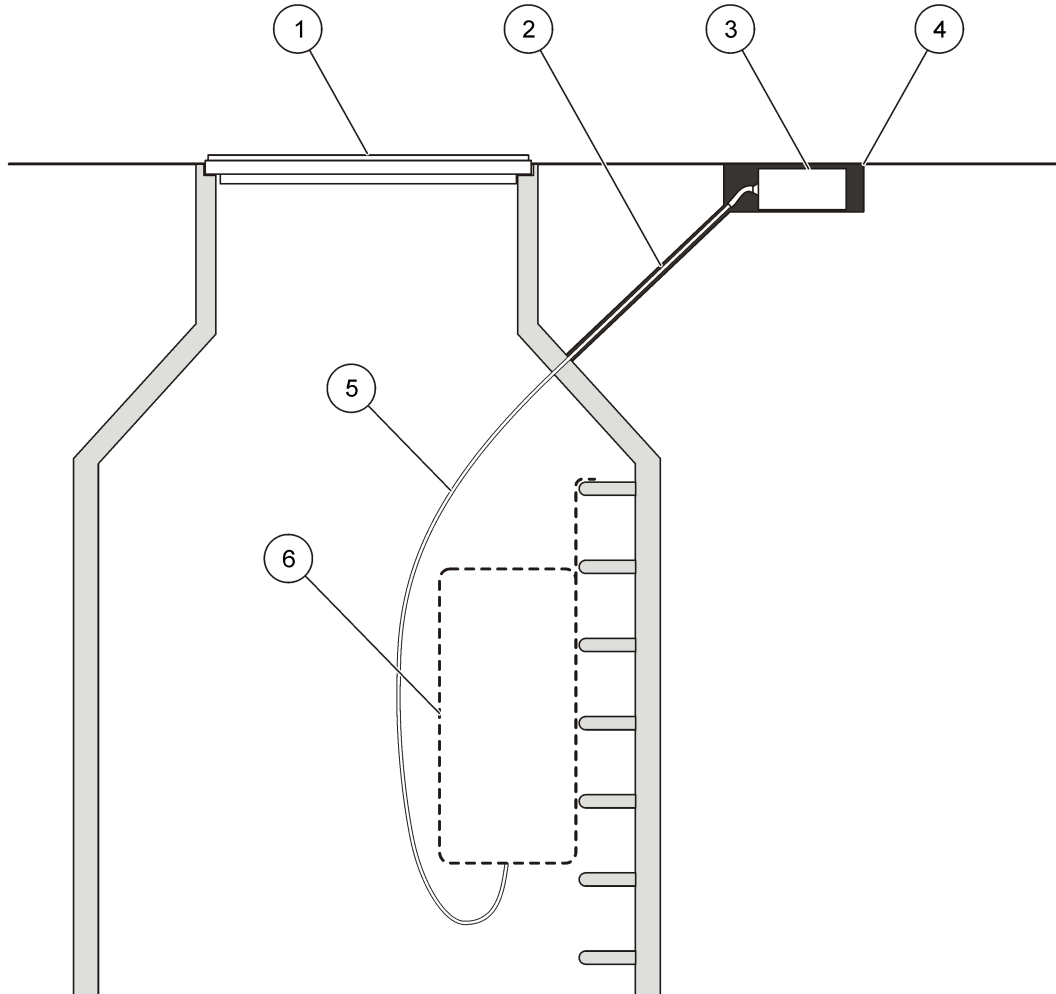
Figure 8 Burial antennas



1 Traffic rated in-road/burial antenna (Verizon)

2 Traffic rated in-road/burial antenna (Sprint)

Figure 9 Burial antenna assembly



1 Manhole cover

2 19.1 to 25.4 mm ($\frac{3}{4}$ to 1 in.) hole

3 Antenna

4 Trench or hole for antenna

5 Antenna cable

6 Flow meter

Replacement Parts

Note: Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.

Description	Item no.
Half wave, 824-894 & 1850-1990 MHz, 3 dBi	5228400
Half wave European, 870-960 & 1710-1880 MHz, 3dBi	5255300
Traffic rated manhole lid quad, 824-896 & 1850-1990 MHz, 3 dBi	5255400
Wing Quad, 824-960 & 1710-2170 MHz, 2.15 dBi	6241804
Traffic rated in-road/burial antenna (Verizon), 824-896 MHz, 3 dBi	6246200
Traffic rated in-road/burial antenna (Sprint), 1850-1990 MHz, 3 dBi	6683000

Tab 4: US³ Company Information

US³ is a California Corporation **Federal ID No. 33-0729605** and qualifies as a Minority Business Enterprise. US³ has certified as an MBE with the California Public Utility Commission's authorized clearinghouse, **Verification Number: 97ES0008**.

US³ is a specialty service company for the Water & Waste Water industry, providing monitoring and control for Utilities since 1996. US³ is in the forefront of this industry by taking the proven technological approaches developed in other high-tech industries and applying them to protect one of our most precious natural resources - our water.

US³ engineers and technical personnel have applied advanced instrumentation system technology to water/wastewater open channel flow monitoring, pipeline evaluation, engineering, and data analysis, all coupled to the power of the Internet. This unique integrated systems approach allows the company to bring greater insight and intelligence to gathering information about water/wastewater system performance of our clients, and in turn, to support the fulfillment of their commitments to manage and cost effectively design, operate, and maintain these systems.

Moreover, **US³** supports Municipalities, Consulting Engineering firms and other water/waste water systems integrators by providing temporary technical services for engineering, software programming and technical site maintenance and calibration site support work, primarily in the Water and Waste Water industries.

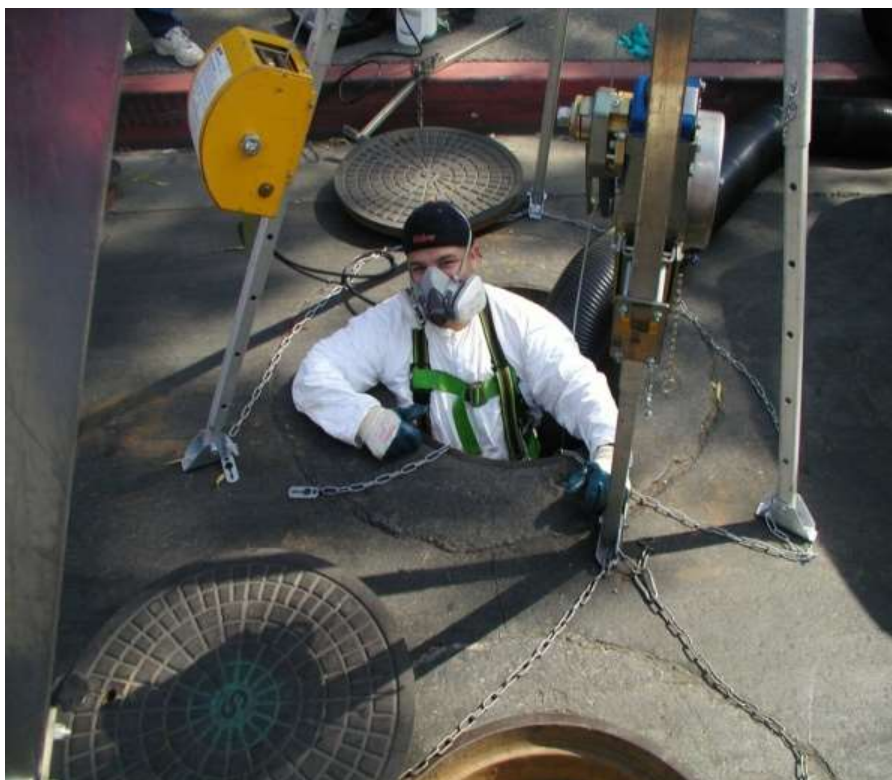


Figure at right: All US³ technicians are certified for Confined Space Entry.

Key Personnel Assigned

US³ provided the necessary resources to fully implement this project. Primary in support of this effort were the following personnel:

Mr. Mark Serres: Mr. Serres is a degreed electrical engineer with over 25 years of experience with fresh/wastewater systems, project management, and systems integration in relation to complex industrial systems. This includes experience in industrial automation and water/wastewater industries. Mr. Serres is responsible for assuring client satisfaction and marshalling the required resources to meet the project requirements.

Mr. Thomas Williams: Mr. Williams is an Engineering Manager with over 20 years of experience in complex systems development for wastewater monitoring. This experience includes hydraulic compatibility, instrumentation, communications and analysis. Mr. Williams is responsible for assuring that the required equipment is designed and calibrated to meet the project requirements.

Darlene Szczublewski, PE: Mrs. Szczublewski is a licensed Civil Engineer in multiple states. She has over 15 years of engineering experience with stormwater/wastewater related projects. She assisted in the completion of several Sanitary Sewer Evaluation Surveys and Capacity Analysis projects to meet Consent Decrees as well as completing numerous Infiltration and Inflow (I&I) studies for other clients. Mrs. Szczublewski has developed numerous flow data analysis techniques to present a clear informative picture of flow in a monitored system. Her work also includes the development of training programs for clients describing I&I and capacity analysis methodologies. Mrs. Szczublewski is responsible for analyzing the data as well as the data collection process and assuring that the reports meet the project requirements.

Name, title, address and telephone number of persons to contact regarding this US³ project.

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Senior Civil Engineer
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